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THE GUIDING-NEEDLE ON AN IRON SHIP.

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THERE is an agency that pervades the earth and is peculiarly resident in all its iron. It is magnetism. This force is akin to electricity, though not identical with it, and the manifestations of both are often similar.

The small steel wire, scarcely larger than a sewing-needle, which constitutes the mariner's compass—every iron vessel, even the huge steamship City of New York, and the earth itself—all have certain properties in common that warrant classing them as magnets; and, as the ship sails the earth and is guided by the compass, there is a very intimate though varying relationship between these three that should deeply interest those who traverse the ocean. To describe this relationship, its contentions, and the constant struggle of each member for mastery, rather than their amicable companionship, is the object of this article; and it will render our ideas of the subject clear if we begin by stating the properties of the ordinary bar-magnet. The needle, the ship, and the earth are but magnets of different size.

The Steel Bar-Magnet.—Fig. 1 represents a steel bar which has been magnetized. Its centers of power are located close to each extremity, while near the middle is a neutral ground over which the influence of neither end predominates. If fine iron filings be sprinkled around the magnet, they will form into curved lines emanating from each center, and eventually trending toward a union.

These centers are called poles. The magnetism in one is opposite in kind and equal in degree to that in the other; there is a mutual attraction between these opposite magnetisms, and this tendency to rush across the neutral ground, and, by combining,

yield up every distinctive feature of the magnet, is successfully opposed by the hardness of the steel bar.

The lines are called lines of magnetic force, and the area over which their influence is felt is known as the magnetic field. If a compass-needle, suspended by a silk thread and free to move in any plane, be brought into this field, it will assume a direction

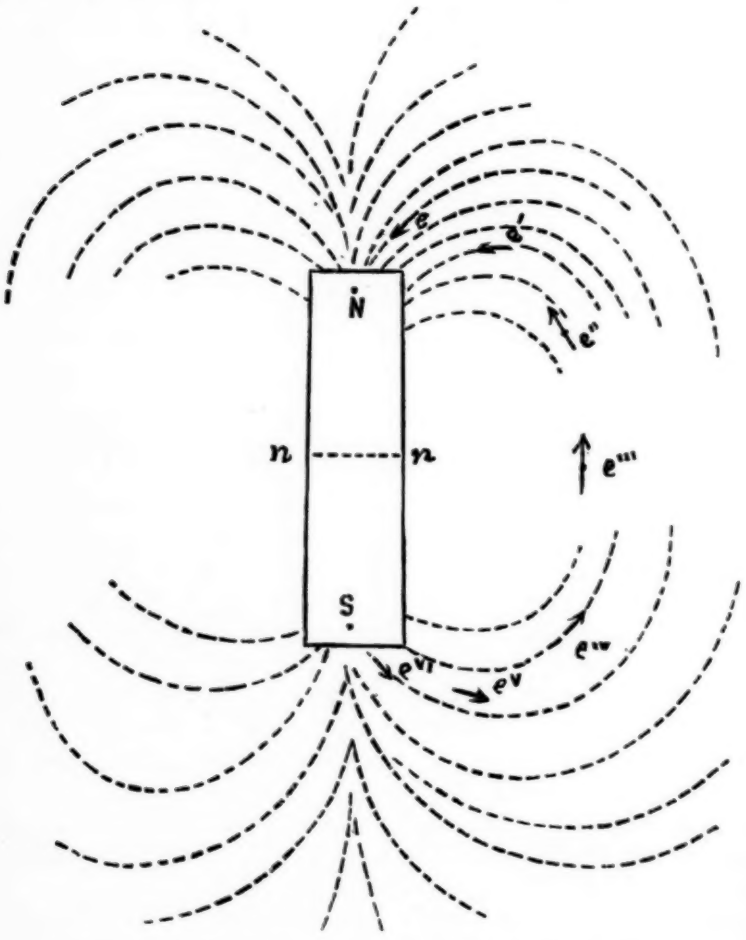


FIG. 1.—THE STEEL BAR-MAGNET. *N* and *S*, poles; *n n*, neutral ground.

parallel to the lines of force, as at e, e', e'' . . . e^{vi}. The strength of the field, and hence the force that tends to give the needle steadiness and direction, varies greatly at different points—at e it is powerful, at e''' feeble.

If two magnets similar to that of Fig. 1 be brought into proximity, so that poles of the same name touch, they will repel each other; if, on the other hand, the north pole of one be approached to the south pole of the other, both bars, as if instinct with life,

will fly into contact and cling one unto the other with the tenacity of a hundred arms. And this intense affinity of opposite magnetisms is a general characteristic.

THE EARTH A MAGNET.—Now, to show that the earth has magnetic features entirely analogous to those of the bar-magnet, we will examine Fig. 2. Here the parallels of latitude and meridians of longitude appear as regular curves. But from a focus at N radiate a series of curves which take sinuous forms and finally

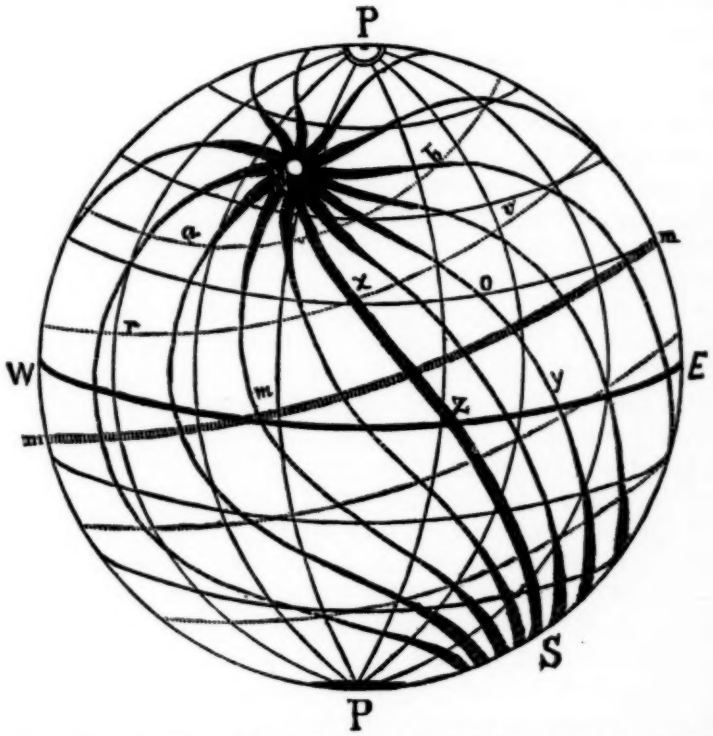


FIG. 2.—THE EARTH A MAGNET. *P P*, geographical poles; *N S*, magnetic poles; *m m*, magnetic equator; *r v* and *a b*, lines of equal magnetic dip; *x z* and *o y*, lines of equal magnetic variation.

converge toward another focus at the antipodes. These foci are the magnetic poles of the earth toward which the compass-needle ever points, not indeed directly, but parallel to the lines of force. These poles are not coincident with the geographical poles, but, on the contrary, are far removed from them.

There are other, but minor, magnetic foci on the earth, just as there are secondary poles in a bar-magnet, but so overtopped in prominence by the two grand foci that they scarcely deserve mention.

The lines issuing from one pole to meet again in the other are called lines of equal VARIATION; that is, a compass carried along one of them from north to south would always point at the same

angle from the geographical meridian, and this angle may vary from 1° to nearly 90° in different parts of the globe.

Thus, then, the variation may be defined as the angle between the geographical meridian and the direction of the compass-needle.

Another set of interesting magnetic lines are those of equal DIP. They gird the earth in circles concentric with the magnetic poles, just as the parallels of latitude do the geographical poles. There is a magnetic equator along every point of which the compass-needle is horizontal. As we travel from the magnetic equator toward the north magnetic pole, the needle begins to incline, the north end tending downward until, when we reach the vicinity of the pole, the needle becomes vertical.

If we travel toward the south magnetic pole, the same occurs with the south end of the needle, now tending downward. An entirely similar experience will result from carrying a small needle through the magnetic field of the steel bar. At the neutral ground it will be parallel to the bar, while, as we approach either end, the dip toward the pole becomes more and more until it stands vertical at the pole. And as it was stated, regarding the steel bar, that the intensity of its magnetic field varies from point to point, so with the earth, it also has a magnetic field which is powerful near its poles and steadily moderates in strength as we approach the magnetic equator.

A third set of lines are those of equal INTENSITY. They are not drawn in Fig. 2. In general contour they follow those of equal dip, though, in point of fact, they are not identical with them.

All these different systems of magnetic lines—variation, dip, and intensity—have not on the earth that symmetry and regularity which they would present around a steel bar; on the contrary, they are often bent, looped, and turned into many a devious path—wherefore, none can tell. The fact alone is well established, while theories fail to account satisfactorily for the earth being an *irregular* magnet.

The observations that have determined the various magnetic features of the earth have been made with delicate instruments in stationary observatories in every country, and also on ships-of-war in every sea.

The magnetism of the earth is not fixed either in locality or amount; but the different systems of lines just described, and by which it has been found convenient to represent this magnetism, are ever varying—ever migratory. The hourly, daily, and other periodic changes are all small, it is true; but, however minute, they are the object of inquiry at every magnetic observatory, with the hope that in time, by the accumulation of data, a satisfactory theory of the earth's magnetism may be deduced.

As the part of the earth's magnetism which affects the com-

pass-needle is the important factor of this article, since the needle, as an instrument of navigation, is specially treated, it will be necessary to dwell further on that element. It has already been stated that poles of opposite name attract and those of the same name repel each other. Now, on the earth, the pole nearest the geographical north is commonly known as the north magnetic pole, and the end of the needle pointing to it is also spoken of as the north pole, whence repulsion would, of necessity, seem to result; but this is an unfortunate use of terms that has grown up in daily life. The real state of the case is, that whichever of the two —the earth's pole, or that of the compass—we agree to designate as north, the other, having magnetism of the opposite kind, must be called south, and hence attraction naturally takes place. To show the variability of this attraction in direction and amount in various parts of the globe, we will examine Fig. 3.

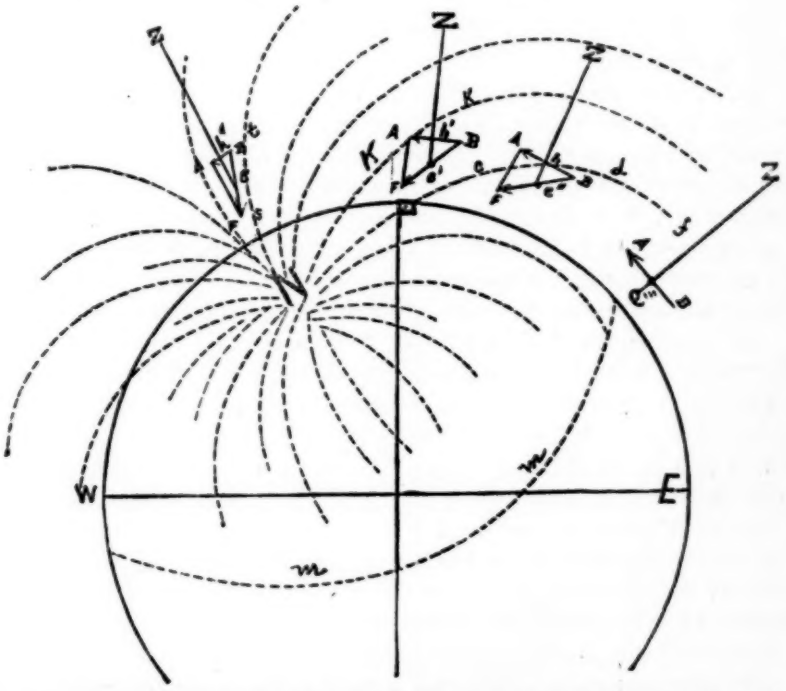


FIG. 3.—VARIABILITY OF THE EARTH'S MAGNETIC FORCE. *P*, geographical pole; *N*, magnetic pole; *m m*, magnetic equator; *Z*, zenith; *s t*, *K K*, *d f*, etc., earth's lines of magnetic force.

Let us conceive the air filled with iron particles as it is with congealed vapor on a wintry night: they will not float about, listless and without form, but, like the frosty foliage on a window-pane, will seem projected from a parent stem, shooting up and out in graceful, wavy filaments. They are the earth's magnetic lines of force permeating space (how far, I do not presume to say),

and coming to a focus at the poles; the mariner's compass is everywhere subject to their influence, and it is this influence that gives steadiness and direction to the needle.

At e, e', e'', and e''' is a magnetic needle, represented as suspended at the middle by a thread from the zenith, and assuming, as it always will, a direction parallel to a line of force. At the magnetic equator (m m) this line is parallel to the horizon, and so is the needle e'''; we go north, and the line becomes bent, so the needle inclines as at e''; proceeding further, the line bends more and the needle inclines accordingly; finally, at e it is all but vertical in the vicinity of the pole. In all these cases the force or intensity of the magnetic field steadily increases from the first toward the last position of the needle, so that, if at e''' it be made to oscillate, the motion will be slow, extend over a wide sweep, and the needle will take some little time to come to rest; at e'' the vibration will be quicker, the arc smaller, and the time less; while at e we will have but a few quick, jerky movements, and then a stop, as if checked by a powerful strain.

Now, a needle dipping thus at every remove from equatorial regions is of no value to guide a ship; it must always be horizontal, and this is practically obtained by placing a small sliding counterpoise on the needle to overcome the downward pull of magnetism; it is easily adjusted with every change. In this constantly horizontal direction of the needle, however, the portion of the magnetic intensity that gives it steadiness is materially changed —lessened and more diminished as we proceed from e''' to e.

Let the length A B at e''' and F B at each of the other points e'', e', and e, represent the *total* force of the magnetic field at those places, then the *portion* of this intensity that is effective in horizontal planes will be represented by the length of the line A B, which is h, h', h'' at each point, and it is readily seen that these lengths are shorter and shorter. And the motion of the needle at h, h' and h'' successively will become slower, more sluggish and uncertain. Thus the seeming paradox is explained that, as we proceed from the magnetic equator toward its pole, the compass becomes less steady and reliable, while, at the same time, the *total* intensity of the magnetic field increases.

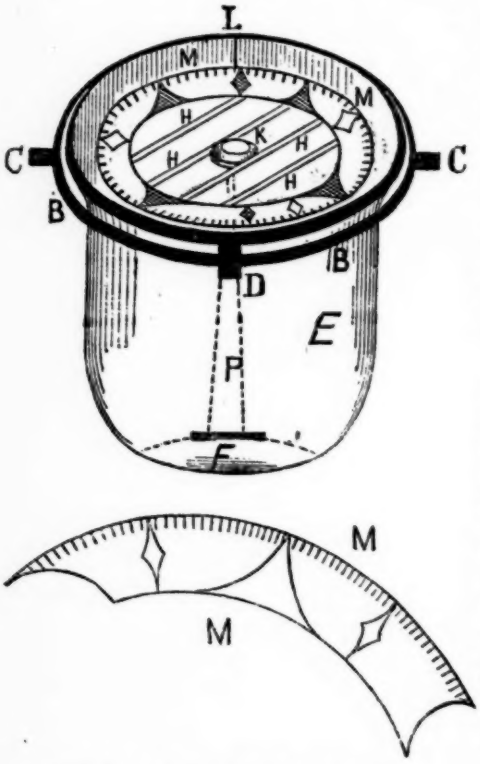
If a wooden ship with no metal other than copper in her frame were to sail round the globe, her compass, adjusted for dip, would experience only those magnetic phases that have already been described as peculiar to the earth—more or less steadying force and a variation of larger or smaller amount according to location; the ship herself would exert no influence whatever. But on board an iron or steel ship, with all her metal equipment and armament, the case is far otherwise; there, contention—unceasing strife—is ever active, as we shall see hereafter.

THE MARINER'S COMPASS.—To relate what is known or conjectured regarding the origin, history, and development of the compass would not be pertinent to this article, and, besides, such information is readily accessible in any encyclopædia; to impart in a general way a knowledge of its construction is more to the point, especially in view of the object of this paper, which is to treat of the behavior of the instrument in an iron ship; and this kind of knowledge is neither easily obtained nor generally free enough from technical terms to be readily intelligible to the non-professional reader.

Like almost every other instrument, the compass has representatives of many a type; to explain the mechanical and magnetical principles of construction, however, in their general application, it is necessary to have reference to some particular type, and for this purpose I shall select the one that in my opinion is the most trustworthy for steering a ship from her port of departure to her haven of destination—the Ritchie liquid compass. This is an American invention, Mr. E. S. Ritchie, of Boston, having many years ago taken out a patent for a liquid compass to be used at sea. From time to time it has been improved, until to-day, in the seven-and-a-half-inch compass supplied our navy, is probably realized the most accurate and complete instrument afloat. So generally has the excellent workmanship of the manufacturer been appreciated, that his compasses now guide the ships of many a nation in every sea. In the wheel-house of the latest large floating structure—the British steamship City of New York—will be found a Ritchie liquid compass.

The compass and its several parts are represented in Figs. 4 to 7, and the reference-letters in every instance pertain to the same parts: *E* is a copper bowl, with two short arms, *D*, *D* (one only being visible), which rest in the grooves of an outer ring, *B*; this, in turn, has two short arms, *C*, *C*, which repose in the sockets of the *binnacle*, as the case for holding the compass on a ship is called. This method of suspension, termed *gimbals*, allows the bowl to swing freely in two planes, so that really it partakes but little of the rolling and pitching motion of the ship. A slender brass spindle known as the pivot (*P*, Figs. 4 and 7) is screwed into the bottom of the bowl, and on it rests the card. The bowl is filled with a liquid composed of nearly equal parts of pure alcohol and distilled water, and is hermetically sealed with a plane glass cover, which permits the card to be distinctly seen without distortion. The card (Fig. 6) consists of an outer rim (*M*), a central bulb (*K*), and four tubes, *H*, *H*, *H*, *H*—all made of very thin sheet-brass. The rim has double curvature—circular around the pivot, and semi-cylindrical from the inner to the outer edge, as shown in section in Fig. 5. The card is painted white, and has

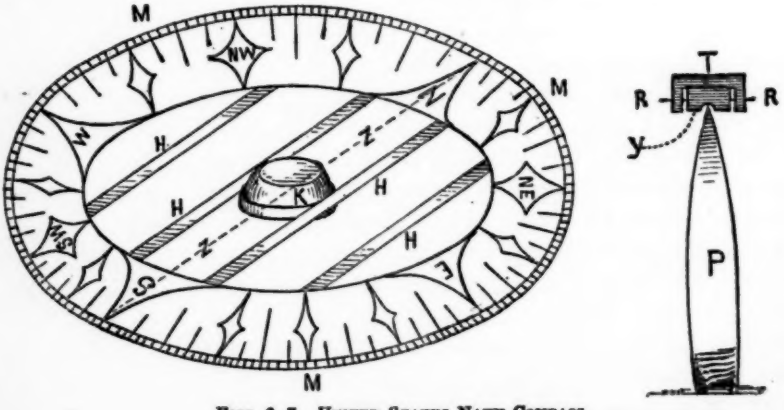
two systems of graduation traced upon its outer edge—degrees and points. The bulb is an air-tight ellipsoid, with a conical depression on its nether surface; in this depression is a small brass cap (*T*, Fig. 7), with four tiny set-screws (*R*, *R*)—only two are shown, however—which press and hold steady in place the jewel (*Y*)—a sapphire hollowed out and smoothed to the utmost degree, so that the highly polished pivot-point upon which it rests may encounter the least friction possible.



Figs. 4, 5.—United States Navy Compass.

The little set-screws are for adjusting the jewel to the very center of the graduated rim. The tubes, which are two of one length and two of another, are about the diameter of a lead-pencil; their extremities are soldered to the under edge of the rim, and in addition the two inner ones are soldered to the bulb *K*; this gives the rim rigidity, as of itself it is both light and flexible.

In the tubes are placed the magnets—the vital part of the compass. These magnets are prepared with the most scrupulous



Figs. 6, 7.—United States Navy Compass.

care. A quantity of the best steel wire, as thick as a knitting-needle, is selected and cut into lengths to fit the tubes; bundles of these wires large enough to enter the tubes are made up and tempered to the degree that experience has proved best for holding captive the magnetic charge. This is imparted to each bundle between the poles of a powerful electro-magnet. Of course, every one of the many slender wires that compose a bundle is itself a magnet; they lie together with their north poles in contact, and likewise their south poles: hence repulsion—a mutually deteriorating influence—is the result; and indeed oft-times a bundle of wires loses much of its magnetic strength because the steel is not of a quality and temper to resist the destructive force.

Each bundle is weighed and its magnetic strength tested, and, in placing them on a card, due care is had to the equal distribution of weight and force on each side of the center, for the characteristic of symmetry is ever kept in view. The magnets, except one, are rigidly set in the tubes, and the latter sealed; the movable magnet has screws at one end for the purpose of adjusting the magnetic axis of the whole system to that diameter of the card which passes through the north and south points: it would be the imaginary dotted line (*Z* . . . *Z*) shown in Fig. 6.

The card as above described, with tubes, magnets, bulb, rim, brass cap, and jewel all in place, weighs many ounces—a heavy weight for the delicate force of terrestrial magnetism to turn about on a pivot, how highly soever both this and the jewel may be polished.

The essential principle observed in the manufacture of the instrument is to reduce the friction on the pivot to a minimum and increase the moving power—the strength of the magnets—to a maximum; and this object is greatly furthered by the introduction of the liquid: its buoyant effect upon the card reduces the pressure of several ounces to that of a few grains.

The liquid has another advantage—it steadies the card, prevents all those small oscillatory movements that characterize a dry or air compass, while at the same time enabling the magnetic power to cope more efficiently with its burden. The liquid must fill the bowl completely, otherwise an air-bubble would gather and impede the free motion of the card.

The same compass may guide a ship into all climates—polar seas and tropical oceans; but as every change of temperature causes a varying expansibility of the copper bowl and the liquid in it, the former, when filled to complete fullness, would soon burst, were no provision made for expansion. To prevent this, an air-tight case of thin flexible metal is placed in the bottom of the bowl, which contracts or expands with every changing press-

ure. The alcohol in the liquid is to guard against its freezing in cold weather.

It has been stated that a single needle suspended by a thread would dip more and more as one proceeded from the equator toward the pole; and that in the dry compass this is prevented and the card always maintained horizontal by an adjustable counterpoise on the needle: no such contrivance is needed in the liquid compass; any downward pull of the earth's magnetism is at once met by such opposite pressure of the liquid on the rim of the card as to neutralize it. Magnetic attraction and liquid pressure counterbalance, and the card remains horizontal.

On the inside of the bowl is traced a fine black line—the *lubber's-point*, or, as it has of recent years been more appropriately designated in the navy, the *keel-line* (*L*, Fig. 4). It is this line toward which the point of the card indicating the ship's course is always directed. The *binnacle* which holds the compass is screwed down to the deck, so that the keel-line, as its name indicates, is in the vertical plane through the keel of the ship, or in a plane parallel to that one. This plane extends from bow to stern, and divides the ship into two equal and symmetrical parts.

Now, let an observer look at the compass-card and keel-line while the ship's bow swings through a portion of a circle: as each point passes the keel-line, it will seem that the card itself is moving, but this is an illusion; the card is still—ever pointing to the magnetic pole, in obedience to the attraction that there exists for the magnetism in the steel wires it carries. But it must not be understood that this attraction is of a nature to pull the card off its pivot: on the contrary, there is no tendency to motion of translation, but merely of direction—to turn the magnets on their pivot and place them parallel to the earth's lines of magnetic force.

To illustrate this, let us examine Fig. 8: *C*, *C* is a steel arrow free to move upon a pivot *P*; from the extremities of the arrow light threads *t* . . . *t'*, extend and pass over revolving wheels at *N* and *S*; small, equal weights *Q* and *Q'* are attached to the ends of the threads. Under the strain communicated to the arrow by the weights, it will, of course, lie in the straight line joining the points *N* and *S*.

Now, with the fingers, turn the arrow into the position *C*, *C*, the threads will assume the positions *t*, *t'*, and both weights will be equally raised. Release the arrow suddenly, both weights will descend, and alternately rise and fall as the arrow makes a series of short and constantly diminishing vibrations, as shown in the positions *C'*, *C'* and *C''*, *C''*, until it finally comes to rest and all is still. Let us replace the arrow by a magnet, and the threads,

wheels, and weights by that mysterious agency we call magnetism, and the oscillations of the magnet, when drawn out of parallelism to the lines of force, will be entirely similar. Such are the efforts of the compass to regain its normal direction when disturbed; and the test of a good compass is the sensitive quickness with which it will turn aside from the magnetic meridian when another magnet is brought near, and the celerity of its return thereto when the intruder is removed.

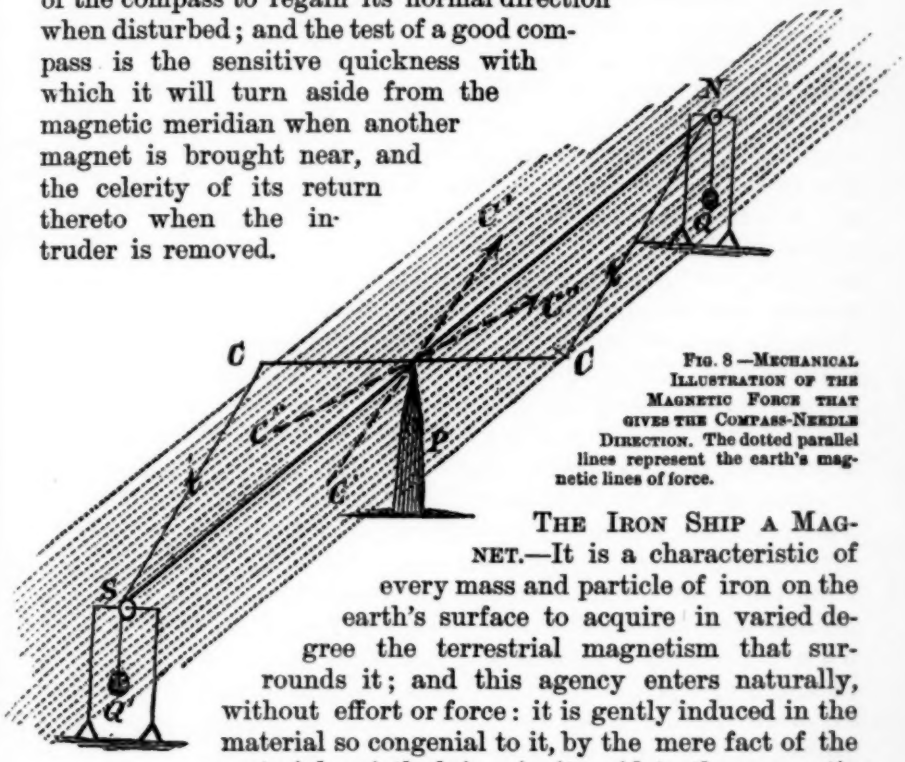


FIG. 8.—MECHANICAL ILLUSTRATION OF THE MAGNETIC FORCE THAT GIVES THE COMPASS-NEEDLE DIRECTION. The dotted parallel lines represent the earth's magnetic lines of force.

THE IRON SHIP A MAGNET.—It is a characteristic of every mass and particle of iron on the earth's surface to acquire in varied degree the terrestrial magnetism that surrounds it; and this agency enters naturally, without effort or force: it is gently induced in the material so congenial to it, by the mere fact of the material quietly lying in its midst—the magnetic field, which pervades all space. And the word *iron* is not here used in a specific sense, but as a general term to include wrought-iron, cast-iron, and steel, which are all susceptible to magnetism.

The steel rails that afford transit from seaboard to interior, the trestle-work upon which the elevated trains traverse the metropolis, the heavy castings in a foundry, the massive forgings in a machine-shop, even the little scraps upon a neglected heap, have one and all magnetic features that distinguish them from other metals, and point out the common kindred among themselves. And these features are entirely analogous to those of the steel magnet already described—two poles, one at each end of the mass, with a neutral belt between.

Let us conceive a metallically pure cylinder of wrought or cast iron that has not been hammered, and let us further conceive it entirely free from magnetism: hold it vertically, and instantly the upper end becomes a south, and the lower a north pole (in this latitude). Reverse it as quickly as we may, and the magnet-

ism also reverses, so that the upper and lower ends are still as they were before—a south and a north pole respectively.

Hold it horizontally in the meridian, and the end toward the north becomes a north pole, while that toward the south becomes a south pole. Revolve it slowly or rapidly in azimuth, and the foci of magnetic polarity also move with the fidelity of a shadow, until, when the cylinder points east and west, all the side facing the north is pervaded by north magnetism, and all facing the south by south magnetism. Again: let us conceive the hull of a ship to be like our cylinder of metallically pure wrought-iron, and as susceptible of magnetic induction in its ever-changing courses as the cylinder is when turned round. Then, as the ship steers north (in this latitude), the bow will become the center of north polarity, and the stern that of south polarity. As she gradually changes course to the eastward, so will the north focus shift to the port bow, the south focus to the starboard quarter, and the neutral line dividing them, which while the ship headed north was athwartship, will now become a diagonal from starboard bow to port quarter. When the ship heads east, all the starboard side is pervaded with south polarity, the port with north, and the neutral line takes a general fore-and-aft direction. Continuing to change course to the southward, the poles and neutral line continue their motion in the opposite direction, until at south the conditions at north are repeated, but this time it is the stern that is a north pole, while the bow is a south pole. At west the conditions at east prevail, only that it is now the starboard side that has north polarity, and the port side south polarity. And this transitory induction in both the cylinder and the ideal ship is solely due to the mild effect of the earth's magnetic field in which they move.

Now, to consider it in connection with an *actual* ship. The hull of no vessel is metallically pure, nor has it acquired shape and stability without much hammering; moreover, it can not be made an abstraction from a magnetic state. By hammering in the process of construction, it has been made as permanent and well defined a magnet as the steel bar, with poles and neutral line as in the bar, but located according to the magnetic direction in which the ship lay on the stocks, in strict conformity to the places they occupied in the ideal vessel just described. Therefore, it is not as susceptible of the mild magnetic induction of the earth as the cylinder and ideal hull, although the straining while on a passage and the buffeting of the waves do assist the inducing tendency; besides, once that the induced magnetism becomes lodged, it does not move and shift with the freedom and facility that it did in the cylinder; and finally, as it already finds a tenacious occupant of the vessel in its permanent magnetism, hammered into it while

building, it must adapt itself to the greater power, and thus it is the resultant of both we always find, and not the individuality of either.

Time is a chief element in the acquisition and efficacy of this induced magnetism; for the longer a ship steers on a given course, or lies in the same general direction, the greater will be the magnetic charge, and the more slowly will it move and shift with the changing courses of the vessel.

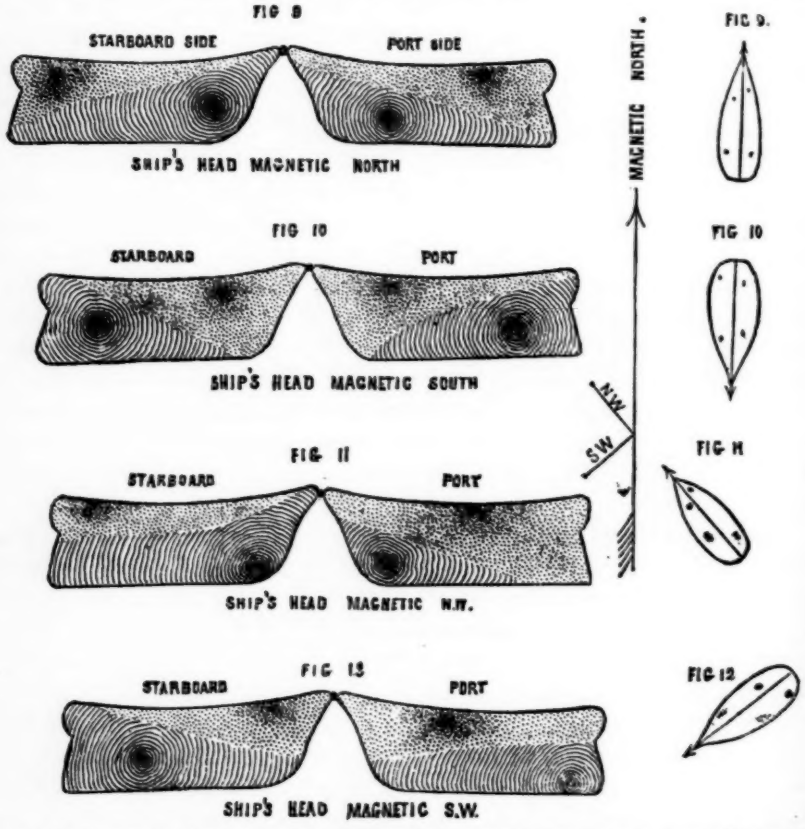
This induced magnetism has been dwelt upon at some length because of its prime importance to navigation.

The other magnetic qualities of a ship are comparatively stable, but this is treacherous and changeable to a degree that necessitates constant vigilance to prevent disaster. On the great fleet of transatlantic steamers it is more likely to lead into danger than on other routes: the ships steer a generally easterly course going to Europe, and a westerly one coming to New York; the magnetic influence on the outward trip is the opposite of that returning; the ships run at a high rate of speed, and the induction varies on different parts of the route, according to the intensity of the magnetic field passed over, the smoothness or roughness of the sea which affects the motion of the ship, and the warmth or coolness of the weather.

Instead of attributing the loss of vessels when approaching a coast to the magnetic effects of fogs and land, and other improbable influences upon the compass, it were much more reasonable to ascribe it to the changed conditions of her magnetism by *induction* during the passage, and which has not been discovered or kept account of by frequent azimuths previous to closing in with the land. Suddenly, a course the captain thought perfectly safe carries the ship upon a shoal or rock, and the fault is laid upon the compasses, whereas they but obeyed the magnetic influences that became altered, during a long passage, from what these influences were when the ship was last swung to determine the deviations of her compasses.

To illustrate the varied location of the poles and neutral line in an iron ship while building, Figs. 9 to 12 are drawn from actual cases. Imagine the ship cut in two by a vertical fore-and-aft plane, and both sections opened out from aft as if turned upon a hinge joining them at the bow; the outside of each half will then appear as on the paper. In Fig. 9, where the ship has been built head north, the whole upper after-body is pervaded by south polarity, while the lower forward portion has north polarity. In Fig. 10, where the ship was built head south, the whole upper forward body has south magnetism, and the lower after-body north magnetism—a condition of induction the opposite of Fig. 9. In Fig. 11, where the ship was built head northwest, we find the gen-

eral magnetic features of a ship built head north, only that now the north magnetism predominates on the starboard side, and south magnetism on the port side. Finally, in Fig. 12, ship's head southwest, we have the general features of the ship's head south, but with the neutral line taking a more horizontal trend, and the south

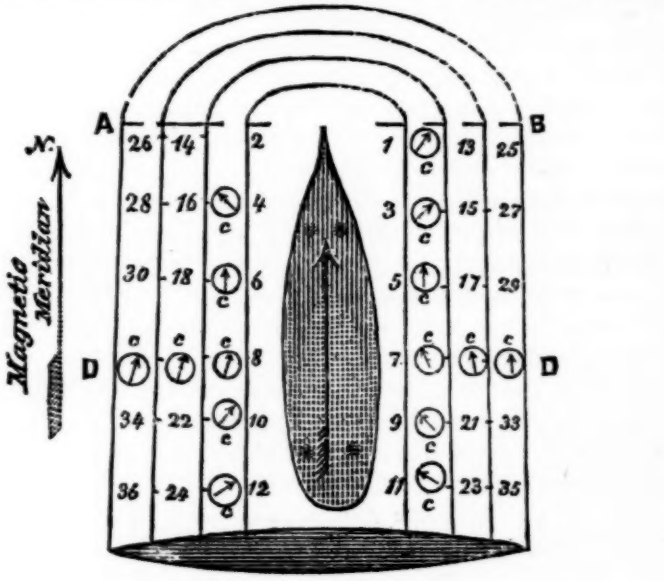


FIGS. 9, 10, 11, AND 12.—THE VARIED MAGNETIC FEATURES OF IRON SHIPS, DUE TO THE DIRECTION OF THEIR HEADS WHILE BUILDING.

polarity lessened on the starboard side and increased on the port side. And all the above is in close conformity to what theory requires.

The means taken for discovering the permanent magnetic character a ship has acquired in building, are a dock-survey, shown in Figs. 13 and 14. To simplify the explanation, let us suppose the ship and dock to lie parallel to the magnetic meridian. Stations numbered 1, 2, 3, etc., are established on the different steps of the dock, and the distance that each is from the line *A*, *B* and also from the ship's side is measured. A compass is taken successively to each station, and the direction in which its needle points is noted. Of course, if no disturbing mass were near, it

would point to the north at every station. But an iron ship is there: so at station 1 we find the north end of the needle repelled from the vessel; the same occurs at stations 3, 4, 16, and many others from bow to keel around the forward body of the ship. Now, only *north* magnetism can produce this kind of deflection: it varies in degree at each station, and where greatest there is its pole. Again: at stations 7, 8, 9, etc., we find the needle's north end attracted toward the ship; hence we have discovered the body of



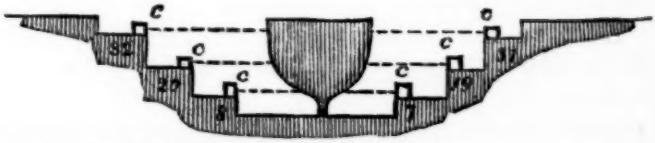


FIG. 13.—PLAN OF A DRY-DOCK WITH A SHIP IN IT.
FIG. 14.—VERTICAL SECTION OF SHIP AND DOCK THROUGH THE LINE *D D* OF FIG. 13.

south magnetism, for that alone can produce this phenomenon, and as with the other, so here, we locate its pole where the deflection is greatest. Finally, at stations 5, 6, etc., in an irregular path from bottom to rail we see that the needle points everywhere to the north: this is the *neutral line*. A sketch of each side of the ship is drawn on paper, and the degree of deflection at every station is plotted by means of the measurements from the line *A*, *B* and from the ship's side.

It has thus been shown that it is a huge magnet, the SHIP,

that is guided around an enormous magnet, the EARTH, by a tiny magnet, the NEEDLE.

The near approach of one magnet to another always excites contention and confusion in the field they occupy, and eventually the old, old story is told—the strongest alone survives. In order that the powerful ship may not paralyze its little guide, great care is taken to find a suitable place for it; and on every voyage, ceaselessly and without fail, a variety of observations have to be made and corrections applied to the courses indicated by the compass, that this may fulfill the object of its being. To explain how this is done would involve a mass of mathematical formulæ and astronomical and magnetical information that would but tire the general reader, besides being out of keeping with the character of this article. Let it suffice to state the problem in popular phrase; to solve it would necessitate the use of other language.

An iron ship—frames, plating, decks, beams, stanchions, carlings, engines, smoke-pipes, yards, masts, shafts, armament in a ship-of-war, and numberless other parts—is not like the steel bar, a simple magnet, but a network of magnetic entanglement; yet, how complex soever this may be, for the purpose of investigation, to the end that proper means may be devised for coping with it, its influence may be considered as taking place in three co-ordinate axes, namely, fore-and-aft, athwart-ships, and vertically downward, with the compass-pivot as the origin. To facilitate this conception, let us contemplate Fig. 15, and let *T* represent a bar of iron of such quality that when held upright it becomes instantly magnetic through the induction of terrestrial magnetism, and as instantly has its polarity reversed upon turning it end for end; in other words, what, in investigations of this kind, is technically known as *soft* iron.

Let this bar, supposed to be anywhere in the interior structure of the ship, take the most general position possible, namely, inclined to the plane of the deck, and also to that passing vertically through the keel.

As already stated, reciprocal action occurs between the magnetism of the bar and that of the compass-needle; the upper end of the former (in this hemisphere) attracts the north end of the needle and repels its south end, while, at the same time, the lower end of the bar repels the north end of the needle and attracts its south end. The difference in distance, however, between the near ends of the bar and needle and their remote ends, enters to such extent that the influence of the remote only modifies, not equals, that of the near ends; the net result may be stated as one of action between the near ends only.

We have thus to deal with but one kind of the bar's polarity; represent its force by a line of definite length, *S T* for example.

This force is resolvable into two others, the horizontal *S H*, and the vertical *S Z*; and the former is further divisible into *S B*, parallel to the midship line, and *B H*, transverse to it.

The magnetic power of the bar is thus resolved parallel to the

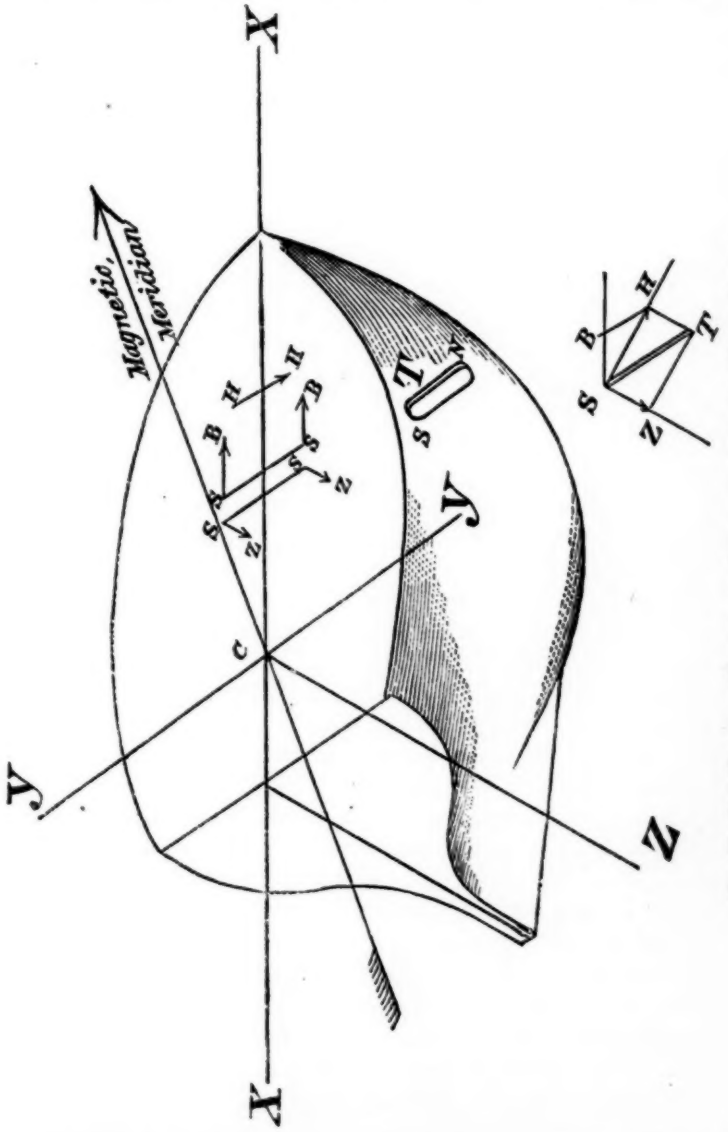


FIG. 15.—THE MAGNETIC FORCES OF A SHIP CONCENTRATED IN THREE PLANES.

three co-ordinate axes. Almost all the structural iron of the ship —beams, knees, engines, boilers, etc.—is symmetrically arranged with reference to the vertical plane through the keel; so that for a piece *T*, on the starboard side, we should generally find another similarly disposed on the port side.

The problem is now simplified to pairs of parallel forces, each pair having its resultant parallel to one of the co-ordinate axes; *and the effect of every magnetic particle, whether of permanent or transitory magnetism, may be reduced to this condition.* We may now with facility transfer into each co-ordinate axis the sum total of all the forces parallel to it, and concentrate the whole upon the north point of the compass, whence the final result, that we have reduced the entire magnetic power of the ship to that of three imaginary magnets—one laid horizontally in the axis of X; the second, also horizontal, in the axis of Y; and the third, vertical, in the axis of Z.

The individual and combined effect of these three imaginary magnets is the object of investigation; but, before entering upon it, it will be necessary to remark that each is not simple, but complex, and that, recognizing this, we shall have to consider *all* the component parts, leaving to every *real* case to determine which of the components reduce to zero, and which are prime factors.

The iron of a ship is of varied quality, from the "hard," which when hammered acquires and keeps its magnetism, to the "soft," which has absolutely no retentive power. It occupies every conceivable direction—vertical, longitudinal, transverse, and inclined at diverse angles; but, however varied the latter, it may be represented in the first three directions by pieces of equivalent effect. Finally, it may be symmetrical or unsymmetrical. To cover all the conditions of the problem, we shall choose representatives of quality and direction, of symmetry and singularity, and let each assert its power in the common struggle.

Fig. 16 represents the arena of these forces; they are arrayed in lines of attack upon the compass.

P, Q, and R, represent hard iron, whose magnetism, the result of percussion, is of a permanent nature, like that of a steel bar; the hull itself of the ship is an example of this kind.

c, f, and k represent vertical soft iron; it becomes magnetic through the inductive agency of the earth's vertical force; c might represent the smoke-pipes; f, boat-davits; and k, stanchions on the deck below that on which the compass is located.

a, e, and g represent horizontal soft iron, the first and last, when in a longitudinal direction, and e, in a transverse direction; the power of this iron is derived from the inductive agency of the horizontal force of the earth; as examples of a may be cited the engines, boilers, and water-tanks; of e, a deck-beam cut amidships for a hatch or any other purpose; and of g (when below the compass), the shaft.

b, d, and h are substitutes for an isolated mass, like T, that has no counterpart on the opposite side, and they proclaim T's influ-

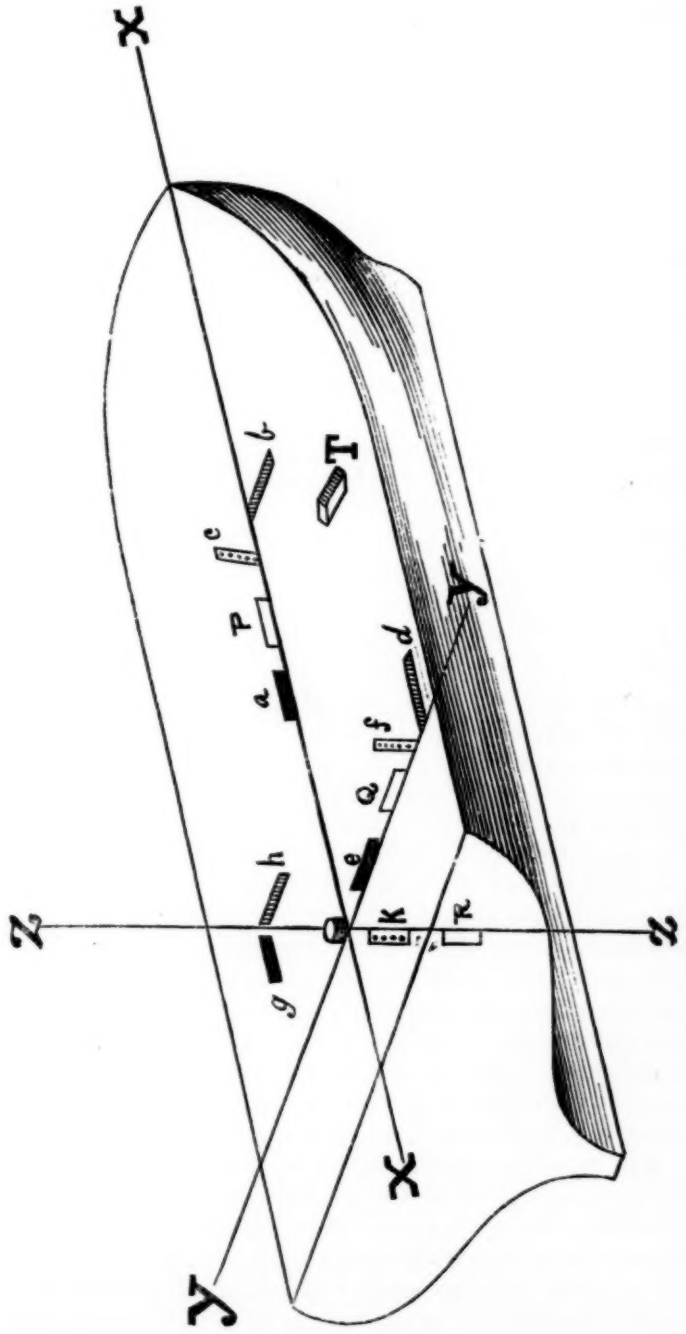


FIG. 16.—THE DIFFERENT VARIETIES OF IRON IN THE SHIP REPRESENTED BY EQUIVALENT RODS.

ence in every direction to which that extends. Soft iron, and both horizontal and vertical induction, are *T's* characteristics.

In all cases of iron which becomes magnetic through the mild inductive influence of terrestrial magnetism, it should be remembered that this influence may be variously modified, if, indeed, not in some instances entirely superseded, by the inductive action of a powerful surrounding field of permanent magnetism in the hull itself.

According to the location of the bulk of each class of iron—the hard and the soft, the vertical, longitudinal, transverse, and unsymmetrical—its resultant or representative, which we may designate as a rod or a bar, will occupy a position relative to the compass, either forward or abaft, to starboard or to port; only one such position for each is shown in Fig. 16; there are, however, two possible positions for every rod, and four for some.

The problem has now been stated, so we will pursue it no further, as the vein of solution would introduce trigonometrical formulæ.

By swinging a ship at compass-buoys, or steaming in a circle on the open sea, the magnetic effect of the ship—that is, of the three imaginary magnets in the axis of *X, Y, Z*—is brought to bear at every point on the needle, causing it to deflect from the magnetic meridian by different angles at different points. These various deflections, being serially arranged, constitute what is known as "a table of deviations." Upon analyzing this, the numerical strength of each imaginary magnet is obtained, and further disintegration exposes to view their individual component parts. And thus it is that from EFFECT we seek backward to an intelligent comprehension of the CAUSE.

But as a ship sails the ocean she passes through ever-varying fields of terrestrial magnetism; also, her own magnetism is undergoing constant change, due to the wrenching and straining, the shock of waves, and the vibrations set up by firing her battery; from this mutability of cause naturally results a variety in the effect—the deviations. They are never the same.

Let a ship proceed to Havana, and she will find them different from the series determined at New York; at Hong-Kong they differ from those at Rio de Janeiro; in tropical seas they are moderate, in polar regions enormous; when a ship is upright, they have one value; when she heels, they have another. Their varying phases are a manifestation of the strife and successive domination of the three magnets whose intimate relationship has been pointed out; now it is the SHIP, as when she steers a certain course for many days and thus strengthens her forces; again, it is the EARTH, when the compass ventures into her frozen strongholds, where it but wavers sluggishly and totters about every course; and finally

comes the little NEEDLE's turn—in the genial tropics, where it can point out steadily and safely the path to any port.

The necessity of frequent observations for determining corrections to be applied to the compass is, therefore, evident.

The series of total deviations is generally divided into two principal parts, the quadrantal and the semicircular: the first taking its name from the fact that it arises, reaches a maximum, and again reduces to zero, all within an angular space of 90°; and the second, for a similar reason, because of its origin, growth, and decline being confined to 180° of the circle.

Frequently, means are provided for opposing the magnetism of the ship by other powerful magnets, thus permitting the needle

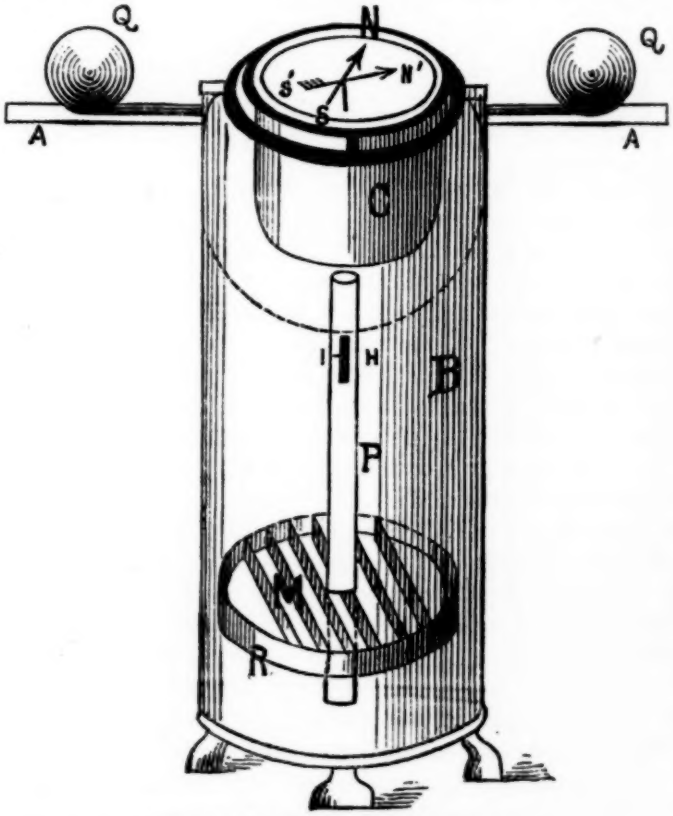


FIG. 17.—THE COMPENSATING BINNACLE.

to point in its natural direction, however the ship may head, Such a contrivance is known as a compensating binnacle, shown in Fig. 17. Before compensation, let the needle point in the direction *N' S.'* A portion of this deflection is the quadrantal deviation, due to the soft iron in the ship; it is overcome by placing two large cast-iron spheres, *Q* and *Q,'* at suitable distances from

the compass; the other portion of the deflection being due to the hard iron (that is, the semicircular deviation), a number of steel bar-magnets, *M*, are placed in a disk, which is turned to the requisite angle and then raised or lowered, until the needle returns to the magnetic meridian *N S*. The magnet *H*, to nullify the heeling deviation, is placed at a predetermined distance vertically below the compass-pivot.

In considerable changes of magnetic latitude the magnets have to be slightly moved to counterbalance the altered condition of the deviations, and sometimes, also, to correspond to a partial loss of power in the magnets themselves.

HOUSE-DRAINAGE FROM VARIOUS POINTS OF VIEW.

By JOHN S. BILLINGS, M. D.,
SURGEON, UNITED STATES ARMY.

IN the year 1596 there was published in London a pamphlet entitled "A new discourse of a stale subject; called the Metamorphosis of Ajax. Written by Misacmos," which was followed in the same year by a second pamphlet entitled "An Anatomy of the Metamorpho-sed Ajax, wherein, by a tripartite method, is plainly, openly and demonstratively declared, explained and eliquidated by Pen, Plot, and Precept, how unsavory places may be made sweet, noisome places made wholesome, filthy places made cleanly. Published for the common benefit of builders, housekeepers, and house owners, by T. C., traveller, apprentise in poetry, practiser in music," etc.

The titles of these little books were in the style of the age in which they appeared; but the contents were something new, for they contain the first description and illustrations of a water-closet which had appeared since the days of old Rome. They contain a good deal more, it is true; for the author, Sir John Harrington, made them the medium of a Rabelaisian satire upon things in general, and his own times in particular, which was of such a character that license to print was refused, and Queen Elizabeth, who was not prudish, forbade the author from appearing at court. His reasons for his device are interesting: "For when I have found, not only in mine own poor confused cottage, but even in the goodliest and stateliest palaces of this realm, notwithstanding all our provisions of vaults, of sluices, of grates, of pains of poor folks in sweeping and scouring, yet still this same whoreson saucy stink, though he were commanded on pain of death not to come within the gates yet would prease to the chambers; I began to conceive such a malice against all the race of

him that I vowed to be at deadly feud with them till I had brought some of the chiefest of them to utter confusion, and conferring some principles of philosophy I had read, and some conveyances of architecture I had seen, with some devices of others I had heard, and some practices of mine own I had paid for, I found out this way that is after described, and a marvellous easy and cheap way it is.

"Here is the same, all put together; that the workman may see if it be well. A, the cistern; *b*, the little washer; *c*, the waste pipe; D, the seat board; *e*, the pipe that comes from the cistern; *f*, the screw; *g*, the scallop shell, to cover it when it is shut down; H, the stool pot; *i*, the stopple; *k*, the current; *l*, the sluice; *m*, N, the vault into which it falls; always remember that the servant at noon and at night empty it, and leave it half a foot deep in fair water."

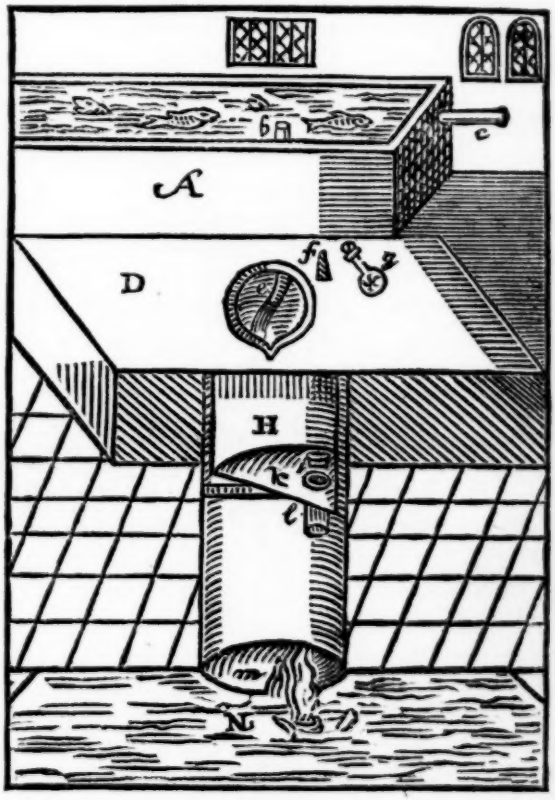


FIG. 1.

It seems a long stride from Sir John Harrington's pet contrivance to the complicated fittings of a water-closet in a modern city house built under existing regulations; but the evolution has, upon the whole, been through complications toward simplicity, as will be seen by Fig. 2, which represents a good form of closet of the present day, and the most important improvements in house-drainage have been made within the last twenty years. We can now say that, so far as the plumbing fixtures in the dwelling-house itself are concerned, freedom from nuisance and a sufficient degree of safety can be secured at a reasonable cost; provided that trustworthy workmen are employed in the construction of the work, and that the apparatus is properly managed

and cared for. Several phrases in this sentence will bear a little amplification.

In the first place, it must be clearly understood that the fixtures and pipes which form an individual system of house-drainage are only a part of the apparatus required for the disposal of offensive and dangerous refuse. Their external connections are

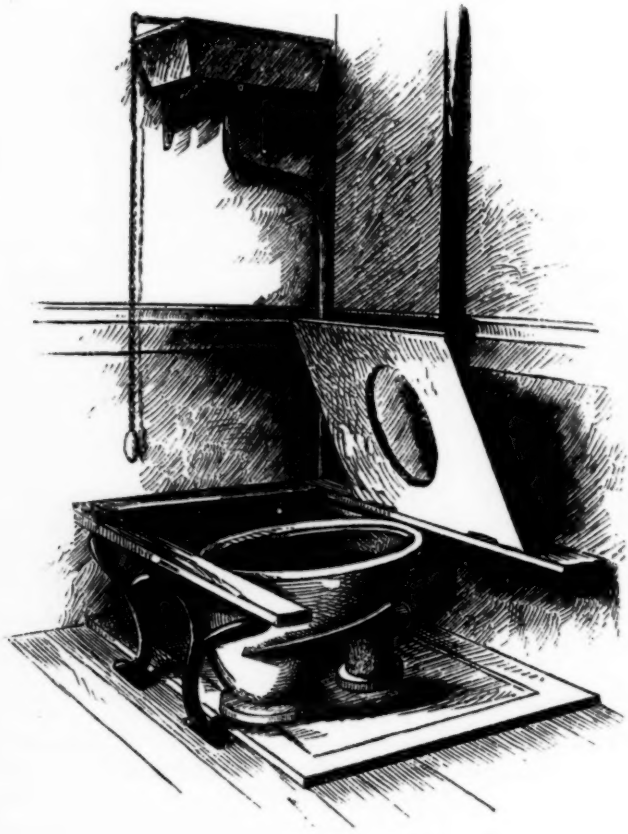


FIG. 2.

an important part of this system, and, according to whether these be with cess-pools or sewers, or whether these last are isolated or are connected with many other houses, will depend the perfection of the results obtained. In this article the house-drains and fixtures only will be considered.

Secondly, what is a "sufficient degree of safety"? Absolute safety can not be guaranteed by any system. If we can so arrange the plumbing that, so far as it is concerned, the air in the house shall be as pure and as free from specific causes of disease as the air in the streets, it is the best that can be done. Reasonable cost refers to that which is essential, and not to that which is

for ornament or luxury; it varies greatly according to the style of house, the essential point being that it shall furnish the means of getting rid of excreta and of water fouled by domestic use, without danger to the health of the inmates of the house.

What, then, are the dangers to health from defective plumbing? They are due to gases or to micro-organisms coming from defective fixtures, joints, or pipe, or from soil pollution due to such defects. The gases in question are, for the most part, products of the decomposition of organic matter of animal origin, and the types are carbonic acid, ammonia and its compounds, and sulphureted hydrogen. There are also produced certain effluvia, of the precise nature of which little is known; the most common is that giving a faint, sweetish, peculiar odor, resembling that of boiled turnips.

These gases and odors do not produce specific disease, but when they are distinctly present in a house the inmates are liable to be affected with various forms of disturbed digestion, loss of appetite, slight headache, and a depressed state of vitality. How far these are due to the gases themselves and how far to the micro-organisms present under such circumstances we do not yet know. The majority of persons gradually become so accustomed to their effects that they can live and work with little or no apparent inconvenience in an atmosphere which is so charged with them as to be not only offensive, but really dangerous to those accustomed to pure air only. Plumbers, scavengers, workers in sewers and at sewage-works, or in bone-boiling establishments, etc., prove this; but it must be remembered that these are survivors, and that a certain number who begin these occupations soon find it necessary to go into some other business. Upon the whole, the dangers from gases only in connection with house-drainage are small, and comparatively easy to avoid, the main thing for this purpose being a complete and constant ventilation of the pipes.

In part the dangers are due to extremely minute particles of living matter, most if not all of which are vegetable organisms known as bacteria. There are many different kinds of bacteria, and they have very different properties and powers, but those which concern us in this connection are those which grow and multiply in decomposing organic matters, and especially in excreta. Almost without exception these bacteria belong to species which are found in the air of streets, in all intestinal discharges, and in all putrefying matters; they are not only harmless under all ordinary circumstances, but are highly useful in decomposing dead organic matter into simple compounds available for the nutrition of plants. They are found in countless numbers in the slimy, pulpy layer of decomposing matter lining the interior

of soil-pipes, which matter they are constantly decomposing into gases and soluble products readily washed away. They are also present in large quantities in sewage as it flows in the sewers.

There are a few forms of bacteria which we have good reason to believe are the causes of certain diseases called specific. Each of these specific diseases has a definite course, and is due to the entrance into the body of particles of living matter derived, directly or indirectly, from the body of a person affected with the same disease.

We now know the particular kinds of bacteria which cause several of these diseases, and can identify them with considerable certainty. Those of most interest in connection with house-drainage are those which are supposed to cause suppuration, septicæmia, puerperal fever, erysipelas, intestinal irritation and diarrhœa, typhoid fever, and sore throats and diphtheria.

These diseases are less frequent and less fatal in sewered than in unsewered cities, and in the central sewered portion of a city than in the unsewered suburbs. Systematic house-to-house inspections in cities have shown that over one half of the houses have more or less defective and foul fixtures and leaky soil-pipe joints, so that if specific germs are often present there should be much more sickness than there is. As a matter of fact there is no evidence that scarlet fever, measles, small-pox, or whooping-cough has ever been transmitted by sewer air. There is reason to think that in a few and exceptional cases diphtheria and typhoid have been caused by inhaling sewer or soil-pipe air; but the danger of incurring these diseases in this way is small as compared with the other and usual sources of origin, although it is probable that the ordinary non-specific sore throats which sewer air tends to produce form a specially favorable site for the development of the specific microbe of diphtheria, and that in this way foul air is a predisposing cause of this disease. Schools are much more dangerous than sewers as regards the propagation of diphtheria.

The typhoid-fever bacillus is said to have been found in the air of a sewer from an institution in which there was an epidemic of typhoid, and there is a theoretical possibility that the disease might thus be produced in a house by conveyance of its germs through sewer and soil-pipe air; but such conveyance must be extremely rare. It should be distinctly understood that neither the most perfect system of house-drainage nor total absence of house-drainage will protect the inmates of the house to any considerable extent from diphtheria or from typhoid.

The most dangerous micro-organisms which are commonly found in sewer and soil-pipe air are those which produce suppuration, erysipelas, or septic poisoning when they gain access to the

interior of the body through a wound of any kind; although they may be inhaled or swallowed with comparative impunity. These are especially dangerous to new-born infants and to lying-in women, as well as to wounded persons. From my personal experience I should say that the forms of disease most frequently produced by sewer and soil-pipe air with its contained bacteria are slight inflammations of the throat, tonsillitis, and mild diarrhœal troubles.

It will be seen, therefore, that while attempts to scare people by depicting the horrors of sewer-gas, etc., in order to prevent the construction of sewers, to promote the sale of certain fixtures, or to improve the house-inspection business are not justifiable, it is certainly true that, upon ordinary insurance principles, it is wise to prevent as far as possible the entrance of sewer and soil-pipe air into dwelling-houses, offices, hospitals, and public buildings; and that a municipality is justified in taking measures to secure such prevention for those who are too ignorant, too indifferent, or too helpless to do it for themselves.

To provide, in an ordinary dwelling-house, a system of pipes and fixtures though which will quickly pass away all excreta and water rendered foul by use in closets, sinks, wash-basins, baths, etc., while the passage of gases and odors from the pipes into the house is prevented, and liability to obstruction of the pipes is as small as possible, is not now a very difficult matter under ordinary circumstances.

The differences of opinion as to the best modes of doing this, which are found in the writings of sanitarians, sanitary engineers, plumbers, etc., and which appear so confusing to one who is not familiar with the subject, are largely due to the fact that the different writers and speakers consider the matter from very different points of view; and it may be well, therefore, to refer to some of these which have the greatest influence in determining opinions.

The first point of view to be considered is that of the man who proposes to build a house for his own family, and who wants to know how he can secure, at a reasonable cost, a convenient and safe system for the removal of excreta and wastes.

If he employs an architect to prepare the plans and specifications for his house, the first suggestion would naturally be that the same architect should prepare the plans and specifications for the plumbing. It is, however, asserted by sanitary inspectors, physicians, plumbers, and popular writers, that architects do not, as a rule, furnish proper plans and specifications for house-drainage; that many of them are not competent to do it, and the rest will not take the trouble; and that to make sure of good results an expert in this particular line must be called in.

The first part of this charge, viz., that architects do not, as a rule, furnish proper plans and specifications for the plumber's work in the houses which they design, is true. They indicate upon the floor plans the positions of sinks, bath-tubs, and water-closets, and specify that the plumber's work must be done to the satisfaction of the architect, possibly stating the particular form of sink or closet that is to be furnished, especially if this has been dictated by their clients. They do not, as a rule, show the pipe-work in section or elevation. A proper set of working drawings for the plumbing of a house, upon which bids are to be made and the responsibility for plan and workmanship is to rest, and which is to be preserved as a guide for future work in changes and repairs, should be almost as minute in detail as the working drawings for the stairways or carved work. These plans and sections should show every pipe, fixture, joint, stop-cock, and trap, in their relations to walls, timbers, floors, gas and steam pipes, and ventilating flues, and give their dimensions. From these plans and specifications a competent plumber should be able, not only to make out a complete list of every length and size of pipe, trap, hanger, and fitting that he will need, but to do a considerable part of the work in his shop and deliver it ready to put in place. It must be admitted that such plans and specifications are rarely prepared, and that when they are furnished they are rarely made in the office of the architect. I do not think, however, that this fact is due so much to the inability of architects to make such drawings and specifications, as to the fact that they are unwilling to take the time and trouble to prepare them unless they are specifically demanded by their clients; thinking that any good plumber will be able to settle all the details of the work if the general scheme is only indicated, and that detailed working drawings are an unnecessary expense. Certainly the course of instruction in our schools for the systematic education of architects includes enough to enable the graduates of such schools to do this kind of work, although it may be doubted whether actual practice in the preparation of such drawings and specifications is sufficiently insisted on as compared with that required in the designing of façades and ornamental carving.

It is wise for the man who proposes to build a house to insist upon having detailed drawings and specifications for the plumbing-work, even if he does not employ an architect; the cost of obtaining them will be saved twice over in the first ten years after the building is completed, and this independent of the influence of the work on the health of the inmates. The drawings should not be folded up and put away, but should be neatly framed under glass and hung in the bath-room in a good light. The general principles to be observed in preparing such plans to obtain

the greatest freedom from nuisance, security to health, permanence of satisfactory performance, and ease and cheapness of inspection and repair, are as follows:

1. Have no more fixtures and pipes than are really necessary, and have all the fixtures as close to the soil-pipes as possible. Do not put fixed wash-basins in any sleeping-room, nor any fixture in such a position that its outlet-pipe must run horizontally, or nearly so, beneath the floor for a distance of more than ten feet before it discharges into the soil-pipe.

2. Avoid, as far as possible, the placing of fixtures in the basement or cellar of the house. In a house properly constructed from a sanitary point of view, the basement or cellar should be entirely given up to heating and ventilating arrangements and to storage, and should not contain either kitchen, laundry, sinks, or closets. All the pipes for drainage, water, gas, etc., should be plainly visible and readily accessible on the ceilings or walls of this lower story, and this can not be effected if kitchen-sinks or laundry-tubs are placed on the lowest floor. This advice can not be followed in many cases because of the expense; but it should be the rule for all houses costing twenty-five thousand dollars and upward.

3. Soil-pipes should be of cast-iron, of the kind known as extra heavy, and, for an ordinary dwelling-house, should be four inches in diameter, weighing about thirteen pounds per foot run. If the soil-pipe must be carried beneath the floor of the cellar or basement, it should be either bedded in cement or put in a brick trench with a removable cover. Every joint in a soil-pipe should be so made that it will not leak when the pipe is filled with water to a height of ten feet above the joint.

4. Provision must be made for the constant passage of a current of air through the soil-pipe from the bottom to the top, and it should have no dead ends. For this purpose it is necessary that the soil-pipe should pass up through the roof and be freely open at the top. It must not be diminished in size above the highest fixture; on the contrary, it is better that it should be slightly enlarged, so that a four-inch pipe may properly be connected with a five-inch pipe above the upper fixture. That part of the soil-pipe above the upper fixture should be of as good material and have the joints as carefully made as that below.

5. In order that a current of air shall pass through the soil-pipe, it must have an opening connected with the air below as well as above. Should this air which is to pass up through the soil-pipe be taken from the sewer, or from the air of the street? In other words, should there be a trap in the soil-pipe between the house and the sewer, with a fresh-air inlet between the trap and the house, or should the trap be omitted and the sewer be venti-

lated directly through the soil-pipes to the tops of the houses? The reply to this is, that where there are properly constructed self-cleansing sewers, having no cess-pool connections, and the house connections of which are made under the control of the engineer having charge of the sewers, it is well to omit the trap between house and sewer, and let the latter ventilate directly through the soil-pipes; but exception should be made to this where the top of a soil-pipe would be on a level with or below the windows of inhabited rooms in a neighboring house. When the house-drains are connected with a cess-pool, or with a sewer presenting the characters of a cess-pool, it is safer to insert the trap; in which case there should always be a fresh-air opening between the trap and the house. If the pipes and fixtures in a house are properly arranged, and the joints are all tight, there is very little risk to the inhabitants of the house itself in having a direct connection with an ordinary sewer without a trap; the danger really being to the inhabitants of neighboring houses. On the other hand, if the trap between the sewer and the house be properly inserted, it creates no risk of danger or nuisance in the house to which it is applied, and costs little. The argument that it checks discharges from the house and tends to produce deposit in the horizontal part of the soil-pipes next to it on the

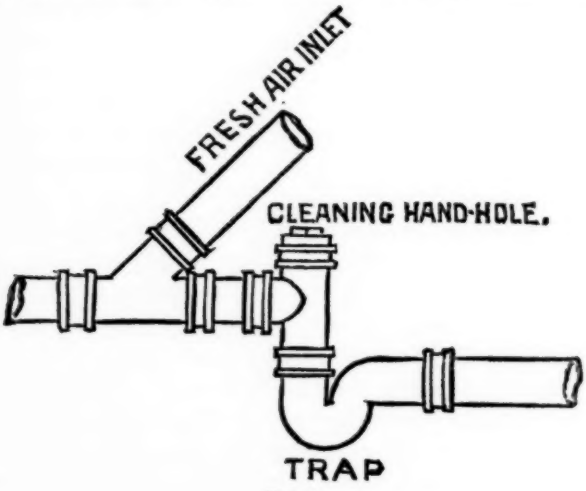


FIG. 3.

house side, is unsound if this part of the pipe has a proper fall and the top of the trap is six inches below the pipe; for I have examined pipes which had been twelve years in use under such circumstances, and found no deposit worth speaking of. A proper form of trap between house and sewer, with fresh-air inlet, is shown in Fig 3. The question is of more importance taken in connection with the ventilation of sewers by street openings as

affecting the comfort and health of the community generally than it is to the individual householder.

6. The incasing of fixtures in wood should be avoided as far as possible. The best bath-tubs and wash-basins are those in which the overflow is through a stand-pipe which is lifted to discharge the water, thus avoiding side or end overflows. The best closets are wash-out, short-hopper or siphon-jet closets. Every closet should have its own cistern, and the flushing-pipe from the cistern should be not less than one and a half inch in diameter. Housemaids' sinks should have a flushing rim and a separate cistern. Fixed laundry-tubs should never be made of wood. Urinals in a private house are usually an unnecessary nuisance; if put in, they must be cleansed frequently by rubbing. It is better that fixtures should be opposite windows than against outer walls, to avoid dark places beneath and around them, and to prevent danger of freezing the pipes.

7. To prevent the passage of soil-pipe and sewer gases, with their suspended micro-organisms, through the fixtures into the house, some form of trap must be used, and this should always be placed as close as possible to the fixture which it is to guard. The best form of trap under all ordinary circumstances is a water-trap made by a bend in the pipe, forming what are known to all plumbers as S or half-S traps. Such a trap, so long as it preserves its water-seal, affords ample protection against both gases and bacteria, and, in ordinary dwelling-houses, it is easily protected against the loss of its seal by evaporation or by siphonage. If a fixture remains unused for several months, its trap will become unsealed by evaporation. In the trap to the outlet-pipe from an ordinary wash-basin this will occur in about two months if the trap is not ventilated, and in about two weeks if it is ventilated. This will be referred to again in speaking of the care of house-drainage. As regards siphonage, the proper ventilation of the traps is a sufficient protection in all ordinary habitations of three or four stories. The ventilation of traps is not, however, solely for the prevention of siphonage; it is of equal if not greater importance to secure a current of air through all parts of the pipes so as to promote the constant oxidation and removal of the slime which lines all pipes devoted to house-drainage. The immediate agents which produce this oxidation or slow burning of the organic matter which smears the interior of the pipes are those bacteria which are called aërobic, because they flourish best where there is plenty of oxygen. These are Nature's scavengers; the great majority of them are not dangerous to health, but rather tend to destroy or starve out the really dangerous specific forms. They convert the soil-pipe slime into gases and soluble products, which products are washed away by the next flush of water; and

they should be given a fair chance to do their work by giving them plenty of air. Where a closet is only three or four feet from the soil-pipe, this ventilation is not necessary for keeping the pipe clear; but it is more than ever necessary to prevent siphonage. It is only under such circumstances that I would use a trap specially difficult to siphon and without ventilation; but such a trap should be cleansed every six months, for a trap which will not siphon will collect filth.

8. Whether the work be for construction or for repair, see that skilled workmen are employed upon it. There is little difficulty in finding in any large city a plumber who understands his business and takes pride in doing good work. He probably will not compete for contracts, and his prices may be from twenty to fifty per cent higher than some other plumbers will demand; but it is wisest to employ the best men, accept their advice, and not grumble about their bills. A competent sanitary engineer, by which is meant a well-educated engineer who has made a special study of water-supply, sewerage, house-drainage, etc., will make the best drawings and specifications, but first-class workmen are required to carry these out; and a class of plumbers is slowly being developed who can make plans and specifications satisfactorily, and whose advice as to fixtures, etc., can be relied upon, and such men should be sought for and employed, no matter what their prices may be.

House-drainage may also be considered from the point of view of the man who wants to know whether the plumbing actually in his house is in such condition that it is or is not worth while for him to make changes or repairs in it. It may not be such a system as he would put in if he were building a new residence; but he does not wish to incur more expense connected with it than is absolutely necessary. If no offensive odors have been perceived, and there has been no sickness in the house which would give rise to a suspicion that the drains might be out of order, he will usually be satisfied, and will not even take the trouble to carefully examine the apparatus, and still less will he be disposed to have it inspected and tested by an expert. If offensive odors are perceived in the house, and cases of disease occurring in it have roused suspicion in his mind, he will probably be more inquisitive; and, if the physician advises skilled inspection, he will usually be willing to have this made. The essential points to be determined by such an inspection are, first, whether there is leakage from any part of the soil-pipe beneath the cellar or basement; second, whether there is any obstruction to the flow of sewage to the sewer; third, whether there is any leakage of gas into the house from any joint or fixture; and, fourth, whether the soil-pipe is properly ventilated and the traps properly ar-

ranged. There are many other details which the inspector will examine; but it is not the object of this paper to describe his work. To determine the points above mentioned the inspector will wish, first, to plug the soil-pipe between the house and the sewer, so that he can fill with water that part of the pipe beneath the cellar-floor, and thus determine whether there are leakage and probable soil pollution, which will necessitate the opening of the floor to find the leak. Next, he will wish to test the vertical part of the soil-pipe, connecting-pipes, and fixtures for gas leakage, by blowing into the pipe from below either smoke or sulphurous-acid gas, or by pouring in oil of peppermint from above. Often leaky joints, damaged fixtures, etc., can be found by mere inspection; but often, also, some such special tests as those indicated above are desirable. The inspector will also wish to know precisely where all the pipes and traps of the house-drainage are, how they are connected, and what are their sizes. If the householder can show him a plan giving this information, it is well; but if not, he may have to prepare one for himself, and for this purpose to take up floors, cut into the walls, etc.

Every house-owner should have such a plan, just as he should have a record of title; and every one who hires a house will act wisely in examining such a plan before signing his lease. The proper time for obtaining this plan is when the drainage system is put in the house. This brings us to a brief consideration of a fourth point of view of house-drainage, viz., that of the sanitary authorities, or officials charged with the duty of seeing that individual premises do not become nuisances or injurious to the public health. Most of our large cities now have regulations with regard to house-drainage and sewer connection, based upon the following principles, viz.: 1. That a man must so use his property that it shall not be a source of offense or injury to others. 2. That the condition of sewers depends, to a considerable extent, on the character and condition of the sewage discharged into them, and that the municipality which is charged with the construction and maintenance of a common system of sewers has the right to regulate, within certain limits, what shall be turned into them. If cess-pool overflows, and sewage from long horizontal reaches of pipe, are turned into the sewer, it must contain putrid sewage; and it will be correspondingly difficult to ventilate it and keep it in proper condition. 3. That the arrangements for house-drainage are intimately connected with those of house water-supply; and that where the municipality furnishes a general water-supply, it has the right to make regulations and inspections to prevent waste and to see that it is properly used.

Municipal regulations for house-drainage vary somewhat in different cities; but in general they provide that, for all new

work, copies of the plans and specifications must be filed at a central office, and be approved by some competent person; that the work as it progresses, or when completed, must be inspected by a municipal officer, and that there shall be a register of those plumbers who are considered competent to do such work.

Usually also there is provision for the inspection of the plumbing of any house when there is reason to suspect that it is in a dangerous condition, or upon the application of the owner or tenant. It is common to require the ventilation of soil-pipes and traps, the trap between the sewer and the house, and the fresh-air inlet, and that all soil-pipes within the house, whether vertical or horizontal, shall be of iron. These regulations are not approved by certain manufacturers and patentees, who find that they conflict with their interests; but upon the whole it is best to allow the municipal health authorities to settle these questions, rather than to have them controlled by trade interests, and it is better to have the rules uniform, and leave as little as possible to the discretion of the officials, even though, in a few cases, this may lead to the putting in of a trap or ventilating-pipe which is not absolutely essential.

The first municipal Board of Health to carefully investigate the subject of defective house-drainage, and to issue instructions and regulations with regard to it, was the Metropolitan Board of Health of New York city under the presidency of Prof. C. F. Chandler, of Columbia College, from 1875 to 1883. To meet the requirements of the board, manufacturers rapidly produced new and improved forms of fixtures, a registration of plumbers was established by law, and the rules and regulations of New York city have practically been the model for those of other cities.

There is still another point of view to which brief reference may be made, viz., that of a man who has a pecuniary interest in certain forms of apparatus, closets, traps, etc., which he wishes to have introduced as extensively as possible. He does not approve of municipal or other regulations which make the use of his appliances difficult or expensive, and he will look favorably on those rules which require the use of his apparatus or its equivalent. It is not to be expected that he will advocate the use of new forms of apparatus, unless, indeed, he owns the patent for them, or has introduced them himself; yet this does not necessarily follow, and still less is it to be assumed that, because a man seeks to promote his pecuniary interests, his arguments and propositions are necessarily unsound, and to be condemned.

Professional men, such as physicians, architects, and engineers, do not, as a rule, look favorably upon the taking out of patents connected with their special work. This is formulated in the code of ethics of physicans in the statement that "it is derogatory

to professional character for a physician to hold a patent for any surgical instrument or medicine." Much the same feeling exists with regard to patenting or otherwise attempting to obtain exclusive control of means for preventing disease, for supplying fresh air or pure water, for disinfection, or for the removal of the foul and dangerous substances necessarily produced by human beings in daily life; and, while the physician, the architect, or the engineer may make use of patent ventilators, filters, traps, or closets, purchasing them as manufactured articles, because they will serve the purpose, and it is easier and cheaper to buy them than to make original designs, yet they avoid giving certificates or recommendations in favor of any such patented article, and distrust those who do so. I state this as a fact, without discussing the question as to whether it is right or wrong, wise or unwise; it is given merely as one reason why in this paper I do not discuss the merits of particular forms of patented appliances for house-drainage, since it is sufficient for my purpose to show that convenience, cleanliness, and safety can be secured without the use of any particular form or piece of apparatus. At the same time it should be distinctly understood that I do not condemn all such patents or patented articles. On the contrary, I believe that the improvements which have been made in house-drainage during the last twenty-five years have been due, to a considerable extent, to the competition of business interests, urged on and directed by scientific investigations made by men who would themselves have never patented an appliance or engaged in its manufacture.

It is to be remembered that, when a system of house-drainage has been made satisfactory, it will not remain so unless it is properly used and looked after. Rust and grease will tend to obstruct the pipes, the tops of lead bends will corrode, cloths and rubbish will be thrown into the fixtures, fresh-air inlets will become plugged by snow or mud, the open top of the soil-pipe may be closed by accumulated ice. One of the most frequent dangers arising from want of care is that which results from leaving the apparatus unused for several weeks or months, as when the family shuts up the house for the summer and goes to some health resort. In a few weeks, sometimes in two weeks, the water in the traps so far evaporates that they are unsealed, and then follows a stream of air into the house, bearing with it micro-organisms which gradually settle in the layer of fine dust which gathers on floors, shelves, ledges over doors, gas-fixtures, etc. If, now, the family returns and occupies the house, using only the ordinary processes of sweeping, dusting, etc., which do not destroy the germs but merely scatter them about, there is serious danger of sickness. On leaving a house in this way, arrangements should be made to

have every fixture in it flushed at least once a week (once in three days is better), and, if it be necessary to move into a house which has been for some time unoccupied, and where you are not sure that these precautions have been observed, then thorough cleansing with cloths wetted with disinfectant solutions should be employed as a matter of ordinary prudence, and this should be applied to every exposed surface.

If the system of house-drainage is properly arranged, and the plans above referred to are at hand, its inspection is a simple matter, and should be made at least once in three years.

Finally, the art of plumbing is not to be learned from books or magazine articles. A man may be M. D., D. D., or LL. D., and be densely ignorant about house-drainage, or as to whether that of his own house is in good condition or not. Every housekeeper ought to be familiar with the pipe plans for her own house, and know just how to turn the water off from any given riser; beyond that, the truest wisdom is to be aware of one's own ignorance, and to get skilled advice whenever advice is needed.

TOWN-LIFE AS A CAUSE OF DEGENERACY.*

By G. B. BARRON, M. D.

IT may be readily supposed that the conditions of life and their general surroundings must largely influence and materially affect the physical or constitutional characteristics of town-dwellers. At the onset, then, I venture to advance the proposition that the "vital force" of the town-dweller is inferior to the "vital force" of the countryman. The evidence of this is to be found in a variety of ways. The general unfitness and incapability of the dwellers in our large hives of industry to undergo continued violent exertion, or to sustain long endurance of fatigue, is a fact requiring little evidence to establish; nor can they tolerate the withdrawal of food under sustained physical effort for any prolonged period as compared with the dwellers in rural districts. It may be affirmed also that, through the various factors at work night and day upon the constitution of the poorer class of town-dwellers, various forms of disease are developed, of which pulmonary consumption is the most familiar, and which is doing its fatal work in a lavish and unerring fashion. Thus it may be conceded as an established fact that the townsman is, on the whole, constitutionally dwarfed in tone, and his life, man for man, shorter, weaker, and more uncertain than the countryman's. I hold the opinion that the deterioration is more in physique, as implied

* Abstract of a paper read at the British Association Meeting, Bath.

in the loss of physical or muscular power of the body, the attenuation of muscular fiber, the loss of integrity of cell-structure, and consequent liability to the invasion of disease, rather than in actual stature of inch-measurement. The true causes of this deterioration are neither very obscure nor far to seek. They are *bad air* and *bad habits*. To these may be added a prolific factor operating largely to produce degeneration of race, and that is, *frequent intermarriage*, often necessitated by religious affinities.

Taking these causes in the order in which I have placed them, but without reference to their relative intensity, I think *bad air* is a potent factor of enfeeblement. Included in the phrase "bad air" are bad sanitation and overcrowding. I have no doubt in my mind that it has a powerful and never-ceasing action, paramount and decisive, on the physical frames of young and old town-dwellers, producing deterioration of physique, lowered vitality, and constitutional decay. For over thirty years I have been hammering away at this question of "bad air" and "bad sanitation" as the prime causes of impairment of health and race, and the more I consider it the more I am convinced of the soundness of my conclusions. A great deal has been said on this subject, and it is not difficult to adduce conclusive evidence from a large variety of reliable sources in proof of the deleterious effects of impure air on the animal economy. Consumption is the best type of degenerative action and loss of vital energy. It stands out in bold relief as the disease most rife wherever foul air exists. The significance and value of fresh air were recognized by the old fathers of medicine. Hippocrates was accustomed to advise a walk in fresh air of ten or fifteen miles daily. Aretæus, Celsus, and Pliny speak of the good effect of fresh air; and our great English physician, Sydenham, did the same thing. Dr. Guy found that of 104 compositors who worked in rooms of less than 500 cubic feet of air for each person, 12·5 per cent had had spitting of blood; of 115 in rooms of from 500 to 600 cubic feet, 4·35 per cent showed signs of consumption; and in 100 who worked in rooms of more than 600 cubic feet capacity, less than two per cent had spit blood. Consumption is only one of the long list of evils to which the town-dweller is exposed. But it is not desirable to particularize all the medical features of this question; their name is legion. It may be well to mention that the Labrador fishermen and the fishermen of the Hebrides, with plenty of fresh air, are practically exempt from this disease. The absence of pure air acts upon the animal economy in much the same way as the withdrawal of light on plants, the result being pallor and feebleness of constitutional vigor. This effect ramifies in every direction; the tissues of which the human body is composed lose their tonicity and contractile power, and even mental integrity may be more or less affected,

The pent-up denizens of the courts and alleys of our large towns, surrounded on every side by imperfect light, bad air, and the general aspects of low life, necessarily degenerate in physical competency, and their offspring is of a feeble type. Fortunately, one antidote is to be found in the nomadic instincts of such offspring. Better the gutter-life and street Arab gymnastics than the sickly incapability of a pent-up cellar child. When people are huddled together in badly ventilated hovels and narrow courts, compelled to live almost without light and air, the effects are soon made clear. The unsavory courts and slums of our large towns can not but be productive of a lowered vital force and impoverished physique. The fact must not be overlooked that there are two classes of town-dwellers: one being those who dwell for a limited number of hours in the day—that is, whose occupation keeps them in close offices and places of business during the day, but who sleep in the suburbs in purer atmospheric conditions; and those who pass the whole of their lives in bad contaminated air without the advantage of a few hours' respite out of the twenty-four. It is with the latter class that my observations deal.

The second chief factor of deterioration—viz., *bad habits of life*—tells a sad story on the physical power of the town-dweller; probably through ignorance, but certainly indifference to the ordinary precepts of health is the rule of life. It is no doubt a fact that intemperance largely exists among this class, and the incidence of debauch upon them is heavier than upon those who live under more favorable conditions. Then the various forms of impurity smite with devitalizing severity the offspring to the third and fourth generations. Moreover, the general tendency of their ailments is of the asthenic type. When we add to these conditions of human existence the influence of imperfect feeding and malnutrition, we get the state of physical degeneracy largely increased and emphasized. In the paper alluded to great stress was laid upon the diet of the town-dweller, as compared with that of the countryman, as tending to degeneracy and impaired health. The digestive capability of the former is of a lower standard, and less capable of dealing with the ordinary articles of diet, than the latter. Consequently, they live on such food as they can digest without suffering—bread, fish, and meat; above all, the last. The sapid, tasty flesh of animals, which sits lightly upon the stomach, gives an acceptable feeling of satiety, so pleasant to experience. Such selection is natural and intelligible, but it is fraught with danger. I quote from the paper: "The chief diet selected by the town-dweller begets a condition known to doctors as the uric-acid diathesis, with its many morbid consequences. Pulmonary phthisis and Bright's disease seem Dame Nature's means of weeding out degenerating town-dwellers." Such are some of the medi-

cal aspects of the case. But it must not be lost sight of that there is a large class who are not able to procure much nourishing food of any kind, but, on the contrary, are forced by poverty to be content with less sustaining dietary, and they adopt another kind of food, not less injurious, but in another way—a diet mainly consisting of bread, tea, and such-like aliments. The time-honored fashion so prevalent among well-to-do people, of five-o'clock tea, may be attended with many advantages socially, but woe to those who take tea four or five times a day, and rely upon it alimentarily!

But it is not the male sex alone that we have to consider. The factors I have briefly enumerated tell a terrible story on the lives of mothers of this part of future England, and their offspring pay the penalty Nature imposes upon those who fail to fulfill her laws. Their children evidence constitutional disabilities of the frame, which is badly and slowly developed, while their mental precocity shows itself in a peculiar adroitness in all the arts of cunning acquisitiveness. It is supposed by some that the effects of mental activity thus early developed interfere with the development of the physique. No doubt the scanty necessaries of life induce a standard of craftiness and cunning which passes muster for intellect at an age which would imply precociousness and superiority, while the country child remains in its first simplicity.

But to the important question, "Is the town-dweller degenerating in stature, or is he not?" there is yet no satisfactory answer supplied. It has been said that such a thing as a pure cockney of the fourth generation is a rarity, and so it may be said of all other large towns. The immigration of country-folk of both sexes into our large towns is a well-known fact, and it is impossible to trace how far marriage supplies an admixture of new blood into the worn-out stock, and thus renovates it and becomes an antidote to decay. Taking the best evidence we possess, we can only approximately arrive at a solution of the problem. I have said that the degeneracy probably is more found in the loss of enduring tone and physical vigor than in inch-measurement. The constant and ever-recurring immigration of the strong and robust countryman into the cities constitutes a steady counterpoise to the downward tendency, and the balance is fairly well sustained. Hence the difficulty of solving the problem. Seven years ago, at the request of the Anthropometric Society, I obtained the measurement of three hundred men of various nationalities, some born in towns, some in the country, of various occupations, of different complexions and temperaments, and of various habits. I failed to discover any satisfactory evidence to lead to the conclusion that in actual inch-measurement the town-bred man was appreciably inferior to the country-bred man. But, so far as my observation enabled me

to judge, the countryman came out incontestably superior in tone of muscular activity. These figures are recorded in the Anthropometric Society's Transactions. Standing alone, they are of no value; they prove nothing, because I had no evidence at what age town-dwelling ceased. It is in the mass of statistics that we can find proof. Mr. Francis Galton, to whom science is so much indebted, has recently recorded some measurements made by himself in his laboratory at South Kensington on men during the Health Exhibition, and has made a comparison with those of Cambridge University men. Mr. Galton's inquiry extended to as many as nine thousand persons. The relation of the two points to a considerable advantage of the Cambridge men:

	Height.	Weight.	Breathing.	Pull.	Squeeze.
Cambridge	68·9 in.	153·6 lb.	254	83	87·5
Kensington	67·9 in.	143·0 lb.	219	74	85·0

These figures appear to substantiate the statistics of the Anthropometric Society: that the average well-to-do man has a higher general physical condition than the average of a lower grade of society; a similar, though not so well-defined, brain-development exists. These measurements, so far as proof of stature is concerned, must be accepted with some degree of reservation. Presuming that the Cambridge students were drafted from the upper stratum of society, and from the country mainly, there is no evidence that the other class were all from towns.

The tables of the Anthropometric Society, as issued by Mr. Roberts and published in the "York Meeting Transactions," state that the result of a comparison as to the average height and weight of the several classes of the population distinguished as (1) the professional classes, including town and country; (2) the commercial classes in towns; (3) the laboring classes in the country; and (4) the artisans in towns. The relative position of the four classes stands in the order stated, Classes 1 and 2 being taller and Classes 3 and 4 slightly shorter than the general population. This relation is maintained throughout, and the tables afford material for study as to the comparative effects of occupation and town and country life on growth. Another table (No. 6) relates to weight. Here, again, the relative position of the four classes stands in nearly the same order, Class 1 being heavier, and Class 4 (i. e., artisans in towns) lighter than the general population; but Class 3 (country laborers) very nearly coincides with the general average, and is, in general, superior in weight to Class 2 (commercial classes in towns). In other words, the occupation of the country laborer places him in weight over the town tradesman, though the latter has the advantage in height.

As regards the physical improvement or degeneracy of the population, the report of the Anthropometric Committee at the Southport meeting says: "Few statistics are in existence which help to throw light on this subject. It is generally believed that the population in the manufacturing towns of the north of England is rapidly degenerating, but a comparison of the measurements of stature and weight given in the report of the Factory Commission, and the report to the Local Government Board of the employment of children and young persons in factories, 1873, show that this is not the case."

What we want is more extensive inquiries as to measurements of persons who have lived in large towns for two or three generations, and compare them with those who have lived in the surrounding country for some generations without admixture. Such an inquiry is surrounded by difficulties, but it alone would be conclusive. My contention is, that it is in the loss of physique, of muscular tonicity, vital capacity, and vital force that the degeneracy is to be found. Let the town-dweller of the same height and weight go to the Grasmere sports or the Braemar gathering and try conclusions in wrestling or games of prowess and endurance with the hill-side man, and the issue will not long hang in doubt; the town man has no "staying power," no "muscular contractile power," and he soon comes to grief. Probably no arrest in the downward tendency of constitutional power can take place until there is some amelioration in the conditions of life to which town-dwellers are subjected. Development and integrity of cell-structure, and the processes of vital organization, are next to impossible under such circumstances of life as those to which they are exposed. This question is a broad one, and involves many ramifications. If all the circumstances connected with the so-called "sweating system" brought out by "The Lancet" Commission can be sustained as facts, a terribly hideous and degrading state of things exists among those unfortunate creatures compelled by the irony of Fate to dwell and work in the slums of our great towns. Their life is little removed from the process of wallowing in dirt, and abiding in squalor and poverty of the most appalling description. They are surrounded by every circumstance of human existence calculated to debase the mind and destroy the body. Is it possible to conceive any state of life more conducive to loss of health and dwarfing of physical development? These poor creatures appear to have no qualifying or redeeming feature in their every-day routine of life. Breathing in their insanitary homes the reeking fumes of unhealthy surroundings, an atmosphere vitiated to the last degree of respiratory fitness, to which are added unwholesome food and consequent faulty assimilation the aggregation must inevitably result in depraved constitutional

integrity. Nor is there the faintest silver lining to this dark social cloud. These people have not the relieving benefit of sleeping in pure air after a day of hard work of twelve or fourteen hours' duration in the disease-laden atmosphere of insanitary workshops, but are subjected by day and by night to conditions as far removed from the sources of health as the poles are asunder. Their daily occupations and mode of life in the workshop are bad, and their homes also are bad.

It may pertinently be asked, What is the remedy to hinder further degradation of racial power, and rescue the town-dwellers from the agencies so powerfully operating upon their physical competency? I fully recognize the cogency of such a question, but I must at once admit my inability to suggest a satisfactory answer. It may to some extent be found in adopting legislative measures. No doubt sanitary reform is doing an excellent work. Insanitary surroundings, overcrowding, uncleanliness, impurity, and intemperance, must all be done away with or lessened. Educate the children in the pure air of the country, make the parents aware of the great constitutional value of sobriety and morality, give them all pure air and plenty of it, and away fly the pale faces, cachexia, lowered vitality, stunted development, muscular attenuation, and the imperfect elimination of functional products.—*The Lancet.*

SEA-LIONS AND FUR-SEALS.

By W. H. LARRABEE.

THE animals of the seal-kind include two groups or families which, with a general similarity of structure, exhibit quite distinct features in their appearance, habits, and movements. The order to which they belong is named *Pinnipedia*, from the structure of the paws, which are webbed down to the ends of the fingers, and in one of the families beyond them. The families are the *Phocidæ*, or true seals; and the *Otariidæ*, eared seals, sea-lions, or sea-bears. Two articles of the same name but very different qualities are derived from them and form important commercial wares. Seal-skin from the true seal has short, bristly hairs, and is used for trunk-covers, coats, caps, gloves, etc.; seal-skin from the eared seals is the soft, fine, glossy fur which the ladies prize so highly, and which has an important place in our luxurious winter wardrobes. These animals are carnivorous mammalia, and breathers of the air; while they hunt their food in the water, they must live out of it; hence they are found most frequently near the water, on the rocks of the coast, or floating on cakes of ice. In connection with the walrus, they have been aptly de-

scribed by some writers as a kind of marine bears. Their bright, intelligent-looking faces are familiar in all our zoölogical collections, and their sports and antics are always amusing, and never fail to collect a crowd wherever they can be observed.

The true seals live in the northern seas. They are the main reliance of the Eskimo for his support, and supply him with food, light, fuel, clothes, thread, strings, and leather. The best-known species is the common seal (*Phoca vitulina*, Fig. 1), which is common in the European seas, and is often seen in New Brunswick and along the New England coast. It is brownish above and white beneath, mottled, pied, or marbled, and has a handsome hair, which is much prized by the Indians.

FIG. 1.—THE SEAL (*Phoca vitulina*).

The Greenland seal (*Phoca groenlandica*, Fig. 2), also called, from the very conspicuous manner in which the fur of the adult is colored, the harp seal, is the animal of which the Eskimos make the most use. The male is grayish-white with black markings, the female brownish with black, and the young snow-white. The animals live in herds on the floating ice along the Greenland coast, and are sometimes carried to Labrador, Newfoundland, and even to England; and they have recently been shown, by Dr. C. Hart Merriam ("Popular Science Monthly," vol. xxvii, p. 140), to be very abundant in the St. Lawrence River as far up as the Saguenay.

FIG. 2.—THE GREENLAND OR HARP SEAL (*Phoca groenlandica*).

The hooded seal (*Stemmatopus cristatus*, Fig. 3) is distinguished from the other species by a membranous or muscular sac on the back of the head, which is penetrated by chambers communicating with the nose, and may be inflated

with air when the nostrils are closed. The marks of distinction between the true seals (*Phocidæ*) and the sea-lions (*Otariidæ*) are very clear. The most obvious mark is the ears: the true seals have no external ear; the sea-lions have ears that can be seen very plainly. Hence is derived the scientific name of the family, which signifies having ears, or eared. The whole external appearance and the structure of their limbs are also different. The true seal has hardly any neck; his head and trunk, closely connected, are short, while his loins are of full length; his body is so round that his little hands can hardly touch the ground; the hands themselves are closely bound up with the body, so that hardly more than from the wrist out is free; and the hind-feet, connected with the tail, are stretched out backward. The confinement of his limbs unfits him for movement on the land, and his progress is nothing more than a series of awkward bumps and wriggles, in which the body is never raised from the ground. His situation is very different in the water, where he can use his toes like the blades of a screw-propeller, work his body to the right or left, up or down, at pleasure, rise to the surface or dive to the bottom, and, his hands furnishing him an excellent system of steerage, direct his movements with admirable precision.

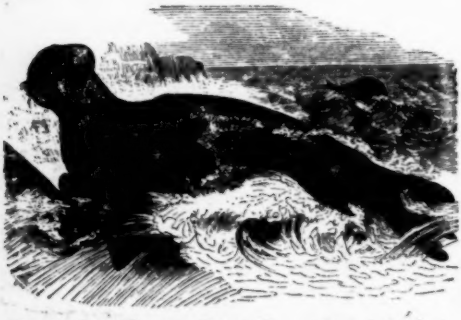


FIG. 3.—THE HOODED SEAL (*Stemmatopus cristatus*).

The sea-lion, having a head with pointed ears, "looking like the head of a dog with his ears cut off," large eyes, whiskers, a long neck, and a body raised upon its hind and fore limbs several inches from the ground, appears upon the land more like a land animal, while it is fully as much at home in the water as the seal. It is much more at home on the land, where its whole body is singularly lithe and flexible, and it can run nearly as fast as a man can, and get along better in a thick bush, can climb rocky ledges and steep, slippery banks. Both in water and on land it assumes a great variety of attitudes. Dr. Murie, describing its motions, says: "At one moment the entire body presents a long, cylindrical, tapering cone; in another the body seems foreshortened, and the head and neck thrust out turtle-fashion, to a length as astonishing as unexpected to any visitor who may chance to be near; at other times the chest and abdomen become deep, and laterally flattened, while the back is arched like that of a defiant cat. And so, waking and sleeping, walking or swimming, there is a ceaseless change of relation in the figure and proportion of the parts. This

does not depend on mere change of attitude, but also on the unusually lithe and mobile nature of the entire spinal column and ribs, furnished as these are with an abundance of cartilaginous material and fibro-elastic ligaments."

The Otaria has generally thirty-six teeth, with canines and incisors of enormous size, so that when they close upon each other "anything that may happen to come between them is held as in a vise," and small molars, so solid that sailors have sometimes mistaken them for flints. According to Mr. J. W. Clark, of Cambridge, whose "Davis Lecture" on these animals at the London Zoölogical Gardens condenses a mass of information about them, "The Otaria, having caught its prey, holds it in its mouth by means of its powerful canines and incisors, and, raising its head, swallows it whole. When it has caught a fish too large to be thus disposed of, it has been seen to give its head a sudden twist, so as to break off a portion, which it swallows rapidly. It then dives into the water, picks up the other portion, and repeats the tearing process until the last fragment is devoured. Their food consists of fish, mollusca, crabs, and sea-fowl, especially penguins, which they catch in a most ingenious way. They lie motionless in the water, with only a small portion of their nose above the surface. This attracts the attention of the bird, which mistakes it for something eatable, and, approaching to catch it, falls a prey to the craft of its adversary." They have also the habit of swallowing pebbles, of which more than twenty pounds, some of them weighing half a pound, have been taken from one animal. The sailors say that this is for ballast, and a story is told of a female seal that was seen teaching her cub to swallow the pebbles; while another story, by an officer of the British navy, is of a sea-lion that was seen "discharging ballast."

The breeding habits of the sea-lions, as they are described by several authors, among them Mr. J. A. Allen, in the "Harvard Bulletin," and Mr. H. W. Elliott, in his report on the Pribylov group of islands, are extremely curious. They frequent solitary islands, away from inhabited coasts, in large numbers, and are supposed generally to return to the same place, or near it, year after year. Here they occupy the spaces between high-water mark and the foot of the cliffs—to which the sailors have given the name of "rookeries"—using the beach as a playground for the pups, and fixing their sleeping-places on the tops of the cliffs.

Only the old males or "married seals," and the full-grown females or "mothers," are allowed upon the rookeries. The young seals—the young males are called "bachelors"—are left to swim about in the water, or are allowed to retire behind the rookeries to the uplands back of the grounds that the old seals have appropriated to themselves. Communication between their upland

haunts and the sea is given them by appointed paths, from which they are not permitted to stray to either side. The rookeries are haunted only by a few stragglers during the winter, but at the beginning of spring the older and chief males of the herd visit the place as if on a tour of inspection, swimming around cautiously, then, if all seems safe, climbing upon the rocks and examining everything carefully. The company increases very slowly till about the first of June; then, if the weather has become warm, the bull-seals come up in large numbers and select their "claims," consisting of a plot of ground about ten feet square for each animal, which he must defend against all comers. Desperate fights often take place for the possession of these little plots, at the end of which the vanquished seal withdraws humbly, while the victor quietly takes possession of his conquest. It is said, according to Mr. Clark, "that occasionally those few males who have been vanquished in all their encounters, and are therefore unable to obtain a resting-place or a wife, retire together to some distant beach, there to bury their shame, far from the society of their fellows, where they sit together gloomily, grievously wounded in body and in temper." The cow-seals arrive in about two weeks after their lords have taken possession of the grounds and selected the places for their harems, and a "universal, spasmodic, desperate fighting" takes place among the bulls. As the females come up, they are met by the "bachelors," whose duty it is to escort them to the beach and drive them up on the rocks as fast as they make their appearance. Some of them seem to be looking for some particular male, and will climb upon the rocks and call out and listen. As soon as the female has got upon the sand, the nearest male addresses her with a noise like the clucking of a hen, bows to her and coaxes her, until he gets between her and the water, when his manner changes and he begins to drive her up with angry growls. He is not yet sure of her, however, for the seals in the next line above him are on the watch to steal the most desirable prizes that their more fortunately situated fellows have captured. They take them in their mouths as cats do their kittens. Sometimes two seals contend for the same female at once, and in this case she gets terribly lacerated and sometimes torn in two. When the distribution of females has been finished, the arrangement is permanent. Each bull-seal keeps the mastery over his twelve or fifteen wives if he is in one of the front rows, five to nine if he is in a back row, and allows no intrusion on his domain. One old bull is mentioned by Mr. Elliott that had forty-five females under his charge.

The pups are born a few hours after the mothers have landed; each mother bringing forth one, seldom twins. The mothers show but little fondness for their young, but can distinguish their cries among the thousands, and each will suckle no other than her own.

The pups begin to take to the water when they are about a month old, clumsily at first, but soon becoming accustomed to the element. The rookery at the Pribylov Islands is broken up during the last days of July and the first week in August. The young have then become able to take care of themselves, and are abandoned by their mothers, who give themselves up to lounging in the waves. The "married seals," who have been constantly at their posts and restlessly active for three months without taking food or water, go down to the sea to feed and wash. Notwithstanding their long fast and hard work, they are not emaciated, but come out in good condition, having sustained life all the time by absorption of the thick stores of fat hidden under their skins. The mothers continue to idle, and the pups and "bachelors" to sport and frolic, till the storms of autumn begin to come on, when they all depart for warmer latitudes, after which they give no account of themselves till the next spring.

Dr. Gray, of the British Museum, made out nine genera and seventeen species of eared seals. He based his distinctions too often on insignificant differences, and erred to excess. Mr. Clark recognizes but nine species, and includes them all in the single genus *Otaria*. While the true seals confine themselves to cool latitudes, the Otariæ bear warmth and appear to be sensitive to changes of temperature, avoiding extreme cold. In the Atlantic Ocean they are found only in the extreme southern part, beginning at the mouth of the Rio de la Plata, and extending thence all around the coasts of South America. They are common on the coast of California, along the Aleutian Islands to the coast of Japan, and in the Pribylov Islands, in Bering Sea, their best-known resort. They are found around the coast of New Zealand, the Auckland Islands, Tasmania, and the south and east coasts of Australia, at Kerguelen's Land and the Crozets, and near the Cape of Good Hope. Most of the skins found in the market are credited to the Falkland Islands, the Cape of Good Hope, and the Pribylov Islands.

FIG. 4.—THE NORTHERN SEA-BEAR (*Otaria ursina*).

The best-known species is the northern sea-bear (*Otaria ursina*, Fig. 4), which inhabits the Pribylov Islands. It frequents those islands in enormous numbers, their whole seal population being

estimated at between five and six millions. The noise of this multitude is described as like the booming of a cataract, so loud as to warn vessels at sea of the proximity of land, and the smell as almost insupportable. The animal is covered with a long, flattened, moderately coarse hair, under which is a dark, long, fine, silky fur, the valuable seal-skin fur of the market.

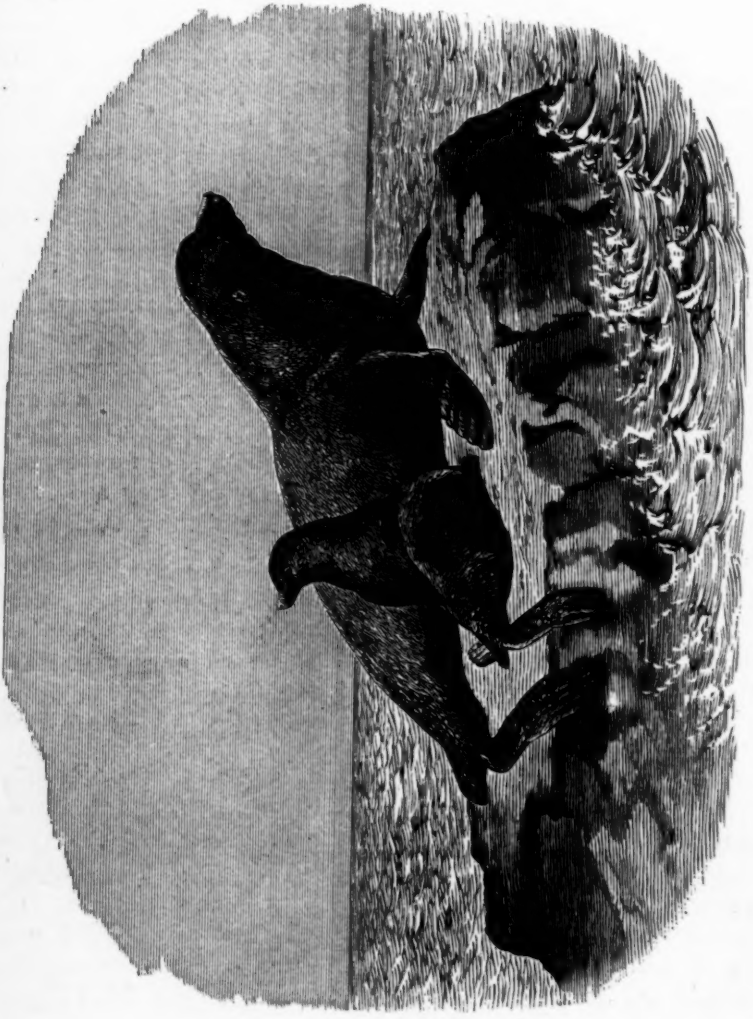


FIG. 5.—STELLER'S SEA-LION (*Otaria Stelleri*).

Steller's sea-lion (*Otaria Stelleri*, Fig. 5) is a larger species, a full-grown male measuring twelve feet in length, and occasionally sixteen feet, and weighing a thousand pounds. It lives not only in remote and secluded places, like the northern species, but also by thickly inhabited coasts, where it enters the bays and rivers, and even plays around the shipping. It is much more timid than the

fur-seal—which shows no fear of man—and "hurries into the water at the first alarm, and there sits, with his head and neck raised above the waves, roaring as loudly as possible, till the intruder is out of sight. Its roar is described as deep and grand, like the howling of a gale through the branches of a forest or rigging of a ship." The species is found on both coasts of the Northern Pacific Ocean, and is the animal which inhabits the "Seal Rocks" of the harbor of San Francisco, and, protected by the law, forms one of the attractions of the city. Its under-fur is so scanty, short, and fine as to be of no use for clothing; but the skin makes an excellent leather, the intestines are used to make water-proof frocks, the whiskers are sold to the Chinese for ornaments, and the flesh, the blubber, the lining of the throat, the skin of the flippers, the stomach, and some of the internal organs, are put to valuable uses.

The southern, or Cook's sea-lion (*Otaria jubata*, Fig. 6), is found around the coasts of South America from Peru to the Rio de la Plata. Its specific name is derived from its possession of a mane, or long hair covering its neck and shoulders, which is developed only in the male when he is fully adult. The fur is only sparsely developed in the young, and disappears as the animal grows older.

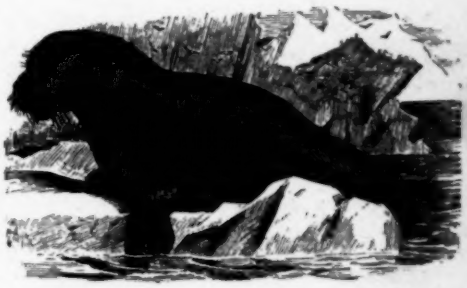


FIG. 6.—SOUTHERN SEA-LION (*Otaria jubata*).

The Falkland fur-seal (*Otaria falklandica*), a small species of not more than four feet in length, inhabits the same localities as the *jubata*. Its habits are identical with those of the northern fur-seal, and its skins, with their thick and soft under-fur, are considered more valuable than those coming from any other region. A similar if not identical species formerly existed in the Australian and New Zealand waters, but it has been exterminated by wasteful hunting, and a correspondent wrote to Mr. Clark a few years ago, "I should as soon expect to meet a sea-lion on London Bridge as on any one of the islands in Bass's Strait." But little is known about the sea-lions of the Cape of Good Hope, which, however, furnish sixty or seventy thousand skins annually to the London market. A reckless system of hunting is tolerated, and the animals are disappearing.

The capture of the seals on the Pribylov Islands is carefully controlled by wise governmental regulations; consequently the animals thrive and are kept up in numbers, while they are fast disappearing in consequence of indiscriminate slaughter from all

other quarters. The Russians established a fur company on these islands immediately after they were discovered, which slaughtered the animals recklessly for thirty years, without any regard to the danger of exterminating them. They began to diminish visibly about 1817, and in 1836 appeared in only one tenth of their former numbers. Regulations were then adopted to limit the slaughter, which have been accepted and enforced by the United States since the islands came into our possession. Only the young males or "bachelors" are allowed to be killed, during June, July, September, and October, and not more than one hundred thousand of them in each year. The "rookeries" must not be molested. The young seals are started from their haunts near the rookeries and driven over the country to the place of slaughter, which is fixed at such a distance as to obviate the danger of the older animals being alarmed by the disturbance or troubled by the odors of the slaughter. The driving is a very tedious process, and is hard upon the seals, for they become heated very easily, when the fur is spoiled, or get exhausted and die on the road. Four per cent of the flock are sometimes lost in this way. The seals are allowed to rest and cool after reaching the killing-ground, and are then dispatched in droves of about one hundred at a time. Only the fittest are slaughtered, all the others being allowed to go back to the sea. One blow on the head with a club of hard wood is generally sufficient to kill. A knife is then thrust into the vitals, and the carcass is laid aside till about a thousand have been collected, when the process of skinning begins. The skins are sent home salted, to be cured and converted into what is called "seal-skin." "It is difficult," says Mr. Clark, "to conceive how that beautiful article of dress can ever be manufactured out of the very unattractive object the skin presents at this juncture. It is hard and unyielding as a board, and the stiff, coarse hairs cover the fur so completely that its very existence might be unsuspected." The important point is to separate these hairs from the fur. They used to be pulled out one by one, till it was found that the roots of the hair were more deeply seated than those of the fur, when a cheaper and more expeditious process was adopted. The skins are now pared down on the wrong side till the roots of the hairs are cut off, when they are easily brushed away, and the fur, of varying shades of light-brown, is left in little curls. The curls become untwisted in the dyeing, and the fur assumes its well-known smooth appearance.

The seal colonies of the Pribylov Islands were leased by the Government of the United States in 1870 for twenty years to the "Alaska Commercial Company," for an annual rent of fifty thousand dollars, and a tax on each skin taken. The details of the slaughter are carefully regulated, so as to promote the well-being

and perpetuation of the colony, and make it probable that, unless some unforeseen disaster befalls it, it will never be less productive than it is now.

The seals of the Greenland seas were hunted a few years ago by fleets from Peterhead, Scotland. At present, Dundee is the only port in Great Britain that sends out vessels to the seal and whale fishings. Wherever the animals frequented, they were found, like the eared seals of the Pribylov Islands, in great herds together; but would collect in the largest numbers in stormy weather, when they would seek the places free from ice, and there gambol lustily. The older seals, according to Mr. James Thornton, who derived his knowledge from frequent conversations with the ship-masters, pursue their prey with great rapidity, and when they come across a shoal of herrings, consume innumerable multitudes of them. They become very drowsy when basking in shoals on the edge of the ice with their young, and in this state are surprised by the boats' crews. Most of the victims are secured by clubbing, as at the Pribylov Islands, but the aid of the harpoon is sometimes called in when the old ones show fight. The Greenlanders, in hunting for seals, find a hole in the ice to which the animal has to come up to breathe. As soon as he puts his nose up, a harpoon is sent into it; the surrounding ice is then broken up and the victim is hauled in and dispatched with a club. The harp-seal is far more idle and wary than the common seal. "It allows itself to be approached by a small boat sufficiently near to be struck by a harpoon with a bladder attached by a long string; the moment the animal is pierced he starts off and dives, but the bladder is a tell-tale, and he is followed and repeatedly struck by an unbarbed lance until quite exhausted, when the man dispatches and takes possession of his prize."

The West Indian seal (*Monachus tropicalis*) was observed by Columbus in 1494, and has since been noticed at scattering times, but the traces of it had recently been nearly lost. Prof. Henry A. Ward, when on a visit to Yucatan and the Triangles in 1886, found several specimens of the animal, and was able to examine it in the adult and fœtal conditions. According to his account in the "American Naturalist," the head is large and prominent, and the whole body chunky, with the bones deeply imbedded in flesh and fat. The eye of the adult is very dull, having over the cornea a film which gives it "much the same appearance as a glass eye or a marble that has been so much handled as to lose its polish." The whole character of the seal is one of tropical inactivity; and this was exemplified by the presence of a growth of minute algæ on the backs and flippers of some of the animals that made them look green. They were never seen to raise their heads above the line of the back, as the harbor seal is accustomed to

do. The animals showed no dread of man on the first approach, but looked lazily at the observers, perhaps uneasily shifting their position, and then dozing off into a restless sleep. But, as the

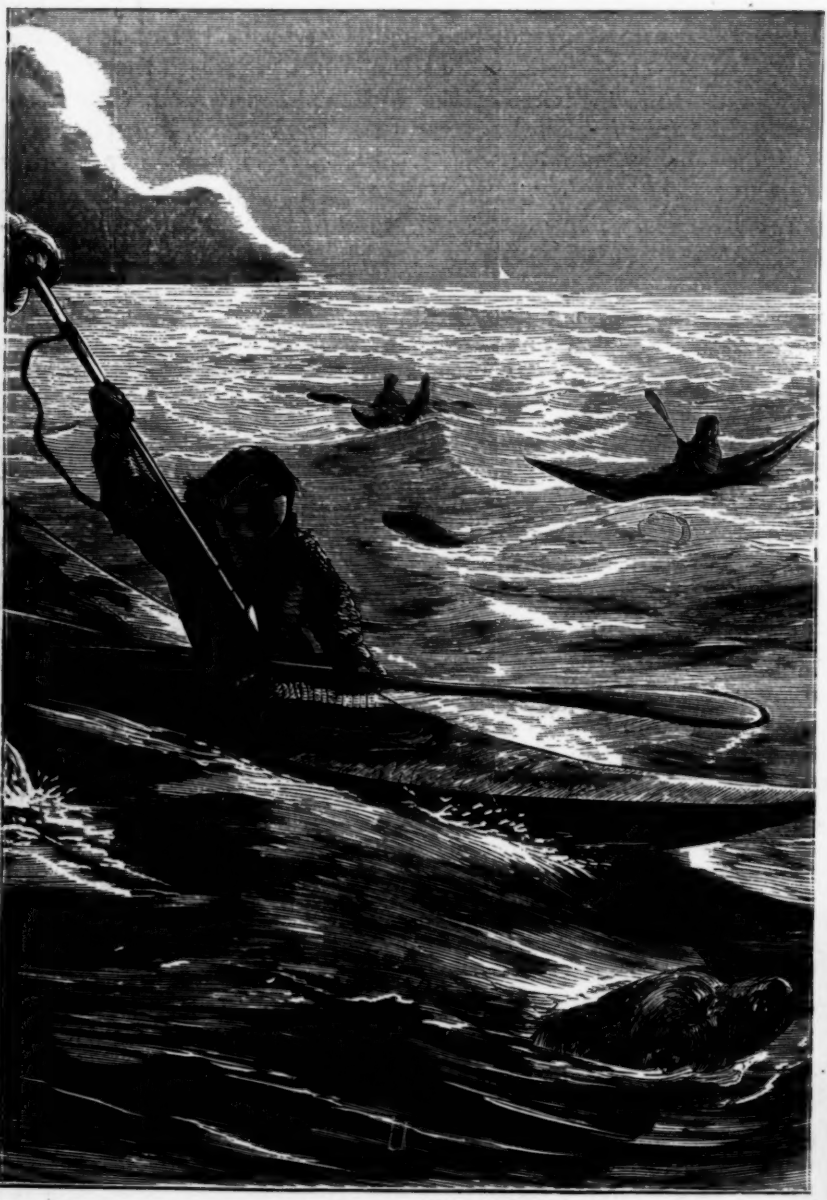


FIG. 7.—ESKIMOS SPEARING SEALS.

men drew nearer, they would rouse themselves, bark, "and uneasily hitch themselves along a few paces." At first they offered little resistance, but on the second day showed fight when attacked

in groups. Except for a little savage conduct when in panic, their whole bearing was one of indecision. They showed but little of the curiosity regarding a boat and its occupants which is usually so marked among seals, and did not disport themselves in play.

The business of hunting the Greenland seals, like the whale-fishery, has been injured by the "improvements" that have been introduced into it. Screw-steamers may be more efficient in the chase than the old-fashioned sailing-vessels, but they have made the seals "wild," and have driven them further north and out of the open waters, into regions to which these vessels can hardly penetrate.

GENIUS AND TALENT.

By GRANT ALLEN.

LET it be granted that a vast deal of nonsense has been talked everywhere in this oblate spheroid of ours about almost every conceivable subject. Yet about none has a vaster amount of nonsense been talked before the tribunal of literature than about the famous old forensic case of Genius *versus* Talent. The born Genius, its sycophants and adulators continually assure us with nauseating persistence, arrives intuitively, by pure force of natural insight, at such and such a magnificent result—a "Paradise Lost," let us say, or a Blenheim Madonna, or a theory of evolution; while mere Talent, poor plodding, purblind, miserable Talent (you should always be extremely hard on Talent, with a few contemptuous crushing epithets, if you yourself wish to be thought a man of genius), toils after it in vain, with painful steps and slow, groping its uncertain way to minor truths or pettier works by the feeble rays of its own insignificant farthing rushlight. So long as Genius till lives, to be sure, and treads the solid earth, known as Genius only to an appreciative few, it does not generally receive this grateful incense of slavish adulation in its divine nostrils to any intoxicating or dangerous extent. Worship is rarely vouchsafed to contemporaries. But when once the Genius is fairly dead and buried (in Westminster Abbey or the Panthéon, as the case may be), it undergoes forthwith its due apotheosis, and a thousand lips cry out to it straightway in deafening chorus, "O Genius, how beutiful you were; how supreme; how grand; how noble; how consummate! O Genius, how masterly was your touch; how intense your feeling; how cosmical your grasp; how profound and searching and absolute your science! Alas, how infinitely did you differ in your ineffable attributes from that unequal substitute which alone we have now left among us—poor plodding, purblind, miserable Talent!" For it is commonly understood among the

mesoteric worshipers of the exalted Genius that their patron is indeed a very jealous god; that he bears, like the Turk, no rival next his throne; and that he harbors in his breast a special grudge against that inferior and groveling, but somewhat similar, deity, mere commonplace Talent. He is known to regard himself, with Hebrew exclusiveness, as the original and only genuine divine entity, all others being spurious imitations.

Now, it is the misfortune of the world in this matter that the lions have chiefly painted themselves; and as the lion in the fable justly anticipated, they have invariably represented themselves as having very much the best of it. Genius, especially self-conscious Genius, has brought copious ghee to its own image; it has erected an altar to itself, like the Divus Cæsar, and has insisted strongly upon the need for public recognition of its own glorious and divine attributes. "Fall down and worship!" says Genius, in the imperative mood; and forthwith a slavish world falls down and worships. Byron, Victor Hugo, Lytton, Disraeli, have all told us, with extreme frankness, what we ought to say and think about them. We have been politely requested, in exquisite verse, to vex not the poet's mind with our shallow wit, on the concise if not very flattering ground that we can not fathom it. Genius, secure of its own Olympic supremacy, has looked down from its airy throne upon the blind and battling multitude below—meaning *us*, of course, who are not geniuses—with a sardonic smile of mingled contempt, beneficence, and pity. And the world, which is very apt to accept men in the long run at their own valuation (so much the worse for the modest), bows down in the end to self-assertive Genius, and sees in its face all those splendid qualities which Genius itself bids it look and find there. For indeed the world is by nature prone, after all, to the attitude of worship. It kneels readily. Though it chooses the objects of its adoration in strange places, yet it bends willing knees to the golden calf; and to the golden calf of success and public approbation none the less than to those other assorted golden calves which we know as wealth, rank, title, and position. It may cast mud at its deities when they are young and unrecognized, to be sure—for who can see divinity in a tweed suit?—but as soon as the voice of the people, which is the voice of God, has decreed them the laurel wreath of common praise and a guinea a line, it will immediately start a Browning Society or a Shelley Society, or, for ought I know, a Ouida Society, too, to give the new cult its appropriate hierarchy. And, above all, where the object of their worship is quite safely dead and buried (for live gods at times inconveniently disclaim their noisiest votaries), the admirers will swarm around with contagious enthusiasm in their wrath against the prophets of all newer cults, and cry aloud for the space of two hours together, "Great

is Diana of the Ephesians!" till the town-clerk comes to disperse them.

On the other hand, if any bold iconoclast, sick of this perpetual adulatory hero-worship, this fulsome laudation of the divine afflatus, ventures to hint that genius, after all, does not really differ so much from mere talent—poor but honest and industrious talent—that the distinction is mainly one of degree, not of kind, and that what in its youth was simply called talent grows with time and repute into genuine genius—the orthodox worshipers have always their thunderbolt ready forged to crush and annihilate him. "This fellow," they say, with a toss of the head, "being in very truth a born frog, ventures to maintain that frogs, by dint of inflation, can puff themselves out to the dignity of oxen, or that at best there is but little difference of size and build between the two species. That is just because he is a mere frog, and jealous of the vast superiority of bovine greatness." To be sure, when the oxen themselves were yet but young bullocks, sporting in the fields, these same orthodox critics would have eagerly contended for their essential frogginess; but now that they are full grown and fat, and florally wreathed with sacrificial garlands, as becomes an Apis, the orthodox have forgotten their former recalcitrancy. As of old, the fathers stone the prophets, and the children occupy themselves with building their sepulchres. But let that pass. The point is, that if one tries to put the question as to the nature of genius in its true aspect, one is at once regarded in the invidious light of a modern Zoilus.

Nevertheless, this question of genius and talent is a truly scientific one, a psychological problem, one might almost say, in the wider sense, a matter of anthropometry. It is well that it should be discussed on scientific grounds, without any of the hysterical and inflated verbiage with which geniuses and their biographers have too frequently befogged it. Wherein does genius really consist, and how does it differ from mere talent? That, simply put, is the net question which we have here categorically to answer; and to anticipate at once the answer forced upon me as a humble observer by consideration of the facts, I find at bottom that the two are in ultimate analysis almost identical. Genius is talent either pushed to an exceptionally high degree, or exerted in a very unusual direction, or linked with a rare amount of striking industry, or dashed with a certain peculiar vein of bizarre originality. In short, it is such talent as makes itself specially remarked—talent which has in it something of the unique; while other talent, often equally great or even greater, but lacking in the special element of individuality, remains to the last "mere talent," and never attains to any higher level of public recognition.

The first form of these four is the one so aptly and bravely

described by Buffon, who defined genius in his own inimitable style as "an infinite capacity for taking pains." To the general public, this admirable definition seems simply incomprehensible. "What!" they cry with one voice, "genius a capacity for taking pains! We wist it was something quite opposite—an inspiration, spontaneous and unconscious. The mere plodder, we always understood or imagined, worked away at his canvas with infinite trouble, touching and retouching till he was sick and tired of it; but the divine genius! oh no, impossible! Perish the thought! 'tis an absolute profanation. The plodder devotes himself with painstaking care to anatomy and perspective and light-and-shade and all the rest of it; but the divine genius, he, great man, comes up with a stroke of his brush intuitively, so—and behold, hi, presto! an Aphrodite or a Beatrice smiles as if by miracle before you. The plodder may potter long over his rhymes and his epithets, but the divine genius, with Byronic carelessness, dashes you off an ode or a ballad, *stans pede in uno*. His lofty Pegasus needs no goading or driving; it moves as it will of its own accord, and leads him at last without conscious guidance to some splendid, glorious, or dazzling conclusion. We know it is true, for have not our Lyttons and our Hugos told us so?"

But humble critics perceive at once that in real life things are ordered quite otherwise. Your Michael Angelos and your Leonardos think no detail of anatomy or of physics beneath their lofty notice; they study the human frame as if they meant to be doctors, the laws of matter as if they meant to be engineers, the nature of light as if they meant to be physicists, the principles of optics as if they meant to be astronomers. They toil early and late over local color and perspective and the chemistry of pigments; they perfect themselves ceaselessly upon models and drapery, upon architecture and landscape. Of course, unusual endowments of eye and hand are there to begin with; but those unusual endowments even will profit them nothing without arduous training and continuous industry. Every line of the greatest and most perfect poets bears obvious traces of utmost care and finish in workmanship; every line of the noblest and most exquisite prose bears evident marks of curious study in adjective and verb, in rhythm and cadence. The art is, to conceal one's art; the seeming felicity, the apparent ease, result, not from spontaneous inspiration, but from long and conscious practice in the adaptation of means to end, and of sound to sentiment.

Indeed, one might almost reverse the ordinary estimate and say that genius, in its most frequent form, is really talent backed up by application. To this special class of genius belong such men (to take a typical example) as Charles Darwin. It was not the mere *aperçu* of natural selection or survival of the fittest that set

the seal upon Darwin's undoubted apostolate. Other men had had that same *aperçu* in greater or less degree before him: some of them smaller men, no doubt, and some of them at least his peers in grasp and ability. Wells had had it years earlier; Patrick Matthew had had it as a passing glimpse; Wallace lighted upon it almost simultaneously; Herbert Spencer trembled more than once with strange nearness upon the very verge of discovery. But what Darwin did was to raise this *aperçu* into the guiding star and mainspring of his active life; to work away at it early and late; to heap together instances *pro* and *con;* to bring out at last after endless toil that banner of a fresh epoch, the Origin of Species, with all its wonderful ancillary treatises. Darwin's mind, though broad and open, a mind of singular candor and acuteness and penetration, was not, in respect of mere general ability, very far above the average constructive mind of the better class of English scientific men. He had twenty contemporaries in the Royal Society who were probably his equals in native intellect and generalizing power. But he had no equals in industry and systematic observation; it was the combination of so much faculty for hard work with so much high organizing intelligence that enabled Darwin to produce so vast a result upon the thought of the world and the future of science, of philosophy, and of politics.

When John Gibson was studying under Canova at Rome, a young English sculptor of the divine genius order—the order represented in our own days by Mr. Richard Belt of funest memory—came to cast a lordly glance in passing around the Roman studios. Gibson himself had been born an artist—not perhaps an artist of the particular type at present exclusively admired by a cultivated clique as supreme and intense, but still in his own way a true and admirable academic artist. Apprenticed first to a wood-carver and then to a stone-cutter, the Welsh working lad determined to make himself a real sculptor. Your boy of talent placed in such circumstances would have considered himself a divinely gifted sculptor already, and would have begun turning out marble nymphs and Ganymedes and Psyches as fast as his active hands could carve them. But Gibson knew better than that. He knew he was a genius, and he determined to behave as such. He went to an anatomy class in Liverpool, where he lived, and he worked with scalpel and saw among the budding surgeons on the bones and muscles of the human frame. When he had studied drawing, modeling, and the use of the chisel, as far as England could then instruct him, he made up his mind to go to Rome; and to Rome he would go, he said, if he had to tramp it on foot. To him thus employed at molding clay in Canova's studio enter the self-taught divine genius, who has come Romeward to glance casually right and left at Michael Angelos and

antique torsos, by way of a hint, but who disdains the vulgar academic aid of masters and instructors. "I thought meanly of him," says Gibson with charming frankness, "for he wouldn't watch other men at work for fear of spoiling his own originality." The divine genius went home to England, carved out his Narcissus and his Aphrodite by the light of nature, ate and drank and died at last, nameless now and utterly forgotten. Gibson stayed in Rome and studied; wasted hours on the turns and folds of a piece of drapery; threw his whole mind into the work of the day; and became at last, whatever the fashion of the moment may say, a true sculptor of immense refinement and delicacy of feeling.

This is the kind of genius that consists of high talent, backed up and re-enforced by exceptional powers of application. It is the kind we get, again, in such a thinker as John Stuart Mill, who really possessed only the average intellect of your picked university honor-man, combined with an unusual faculty for hard work, and a trained habit of keeping his mind open judicially to every breeze of varying opinion. It is the kind we get, again, in Macaulay, who added, however, to his strictly average endowments of intellect the special endowments of a marvelous memory, great command of mere language, a certain ready amount of specious brilliancy, and a singular ability for calling up and adorning concrete images. On the other hand, Macaulay's intellect, viewed as intellect pure and simple, was thoroughly commonplace, *banal*, and Philistine; he had less real thinking power, less native faculty for grasping abstract or subtle ideas, than nine out of ten ordinary educated people. It is the kind, once more, we get in most geniuses of practical life, political or social. Directed to statemanship, this high general level of ability, backed up by industry, gives us our Gladstones, our Guizots, and our Lincolns; directed to war, it gives us our Cæsars, our Napoleons, and our Wellingtons. If any man imagines that the great general wins battles by mere force of innate genius, he has only to remember the constant recurrence in the "Commentaries" of the *res frumentaria*, and the famous saying that an army "fights upon its belly." A good breakfast for his men is the chief aid to a commander's military reputation. Did not somebody once call the mighty dictator, indeed, a "monster of diligence"?

Very different is the sort of genius of which Thomas Carlyle and Charles Dickens form excellent typical examples. This is the particular species of the class on which, perhaps, the popular ideas of the characteristics of genius are mainly founded. In such cases, the genius really consists in large part of eccentricity —eccentricity pushed to an extreme in certain directions, but combined with more or less of real ability. Now, it is important to note that genius of this sort does not necessarily imply a high

order of intelligence. Dickens's intelligence, for example, was by no means high; I suppose everybody would admit at once that you may search his works in vain for a single sentence worth quoting as a specimen of profundity, or insight, or wisdom. Not that I wish for a moment to run down Dickens; on the contrary, I admire him immensely; I never take up "David Copperfield" or "Nicholas Nickleby" without standing amazed and aghast afresh at the quaintness, the fertility, the oddity, the fun of his inimitable creations. No other man, we feel, could do the like; and that is just why we appreciate Dickens. Originality, in fact, is the special note of this particular type of genius; and originality is therefore often spoken of by hasty thinkers as if it were the essence of genius itself. This, however, is not strictly true, unless we mean unduly to restrict the limits of genius. There have been many great men—undoubtedly great—who were far from remarkable for their originality. The solidest intellect is often utterly wanting in brilliancy or originality. Rather is it the truth that a marked degree of original quaintness entitles even a second-rate man (and Dickens was, in the matter of pure intellect, essentially second-rate) to ungrudged admission upon the final roll-call of the immortals.

Many men have had grotesque and morbid imaginings. Dickens had them grotesque and morbid to the point of uniqueness; therefore we rightly call him a genius. His gift was not a very high or noble one; on the contrary, it was one which, in its lesser developments, belongs rather to the buffoon and the caricaturist. But in Dickens it grew so large, and so far monopolized the whole field of his invention, that it became in itself a title to immortality. Nobody else could do anything equal to it, though many people could do something in a somewhat similar but less profoundly absurd and original vein. Such men as Mill, and Bain, and Lewes, and Lyell, overtop Dickens intellectually by more than half their stature. But you might get a hundred philosophers and psychologists and men of science out of a given country before you got another "Martin Chuzzlewit." It is precisely the idiosyncrasy of the man, the mixture of faculty, that is so rare and unusual. Compound ten million human beings on the ordinary principle of mixing together ancestral strains, and among them all you will produce on an average half a dozen apiece of geologists and historians, but never again a single Dickens.

Genius of this sort, then, is not necessarily at all great; it is only unique, and in virtue of its uniqueness for the most part interesting. Not that all eccentricity and originality partake of the nature of genius either; they must have combined with them some considerable element of distinct cleverness, or they result merely in an eccentric or an original, not in a genius, properly so

called. We have all known many eccentrics whose eccentricity was far indeed from being either amusing or curious; it succeeded merely in making itself supremely annoying or absurd. But the gulf that separates the mere original from the true genius is often as narrow as the gulf that intervenes between the sublime and the ridiculous. Everybody has met odd people, who lived by themselves in odd rooms, who said and did odd things, and whose veriest commonplaces had always about them some lingering flavor of misplaced wit and half-mad imagination. Such queer people, with their dash of insanity, have not infrequently a dash of genius as well, only in their case the divine spark has either never been supplied with sufficient fuel, or never blown up by the breath of appreciation into even a struggling and tentative blaze. Yet who shall say what tiny extra twist in a special direction turns any one of these undiscovered cranky souls into a Dickens, a Heine, a Rabelais, or a Cervantes? The little additional twist makes to us, the percipients, all the difference; but in the brain and mind of the man himself, how infinitesimally small must be the peculiarity of fiber or energy that ultimately determines it!

Look, again, at such a case as Carlyle's. Hundreds of caustic, saturnine Scotch laboring-folk have something the same quaint power of expression, something the same dour, grim humor, something the same vehement, self-assertive egotism. In all fundamentals, philosophical and psychological, they are absolutely identical with the grumbler of Chelsea; their hard Scotch Calvinistic creed is just his gloomy pessimism in the rough; their firm belief in a lawgiver of the cosmos, who loves neither fools nor knaves overwell, is just the crude, unelaborated form of the Carlylese political and ethical system. Add a certain native vigor and directness of language, derived by blood from that canny, clever, uneducated sage, the Ecclefechan stone-mason, the "body wha had sic names for things"; supplement it with an Edinburgh University training, backed up by a strong dose of congenial dreamy German metaphysics; turn it loose upon the world of London, or divert it by circumstances into the hard, underpaid literary channel—and a Carlyle at once emerges upon you, bursting forth in the full tide of his "picturesque bad style," in "Sartor Resartus" and the "French Revolution." Once worked, the trick can never be worked again; but, while it lasts, its effect is marvelous. The rush and go of that full tide carries us all unresistingly before it: we never pause to ask for a moment, as we whirl along helter-skelter down-stream, by what slight variations on a familiar theme the astonishing sense of hurrying, scurrying, clashing music, as of pent-up waters bursting their dams, has been laboriously designed and produced in the far recesses of that wild composer's peculiar idiosyncrasy.

If we look, however, at the families of recognized geniuses, we sometimes see, as by a flash of electric light, on what slight accidents of composition these strange results ultimately depend. "Is her sister like her?" asked an enamored poet of a friend of the family. "Very like her," the common-sense friend responded cautiously; "but I wouldn't advise you to see her just yet, or you'd find out too soon how the trick is done." For very often, the slightest exaggeration of the features in a beautiful face will make it at once either commonplace or grotesque. The family likeness in the plain sister suggests forthwith how readily with a turn more of the brush or the knife that chiseled profile might become too painfully Roman, those rich lips too obtrusively negroid, those full eyes too prominent or too lachrymose. You see with undue clearness in such cases the narrow line that separates strength from coarseness, delicacy from feebleness, the pretty from the doll-like, the stately from the hard-featured. Even so, in the families of acknowledged geniuses you see how slight indeed are the special points which distinguish the distinguished: how little the poet differs in fiber from his brother the parson; how near the dry argumentative cobbler comes to his son the materialist philosopher. Bandsman Herschel had a taste for clock-work, for mathematics, for times and seasons: his boy William, who played the oboe in the same Hanoverian regiment, and deserted in due course to be organist at Bath, carried the like tastes just a step further by making a telescope and discovering Uranus. But all his brothers and sisters were also musical, and most of them were mechanical and astronomical as well. The divine genius of William Herschel is just the general family twist, developed perhaps a trifle higher, accompanied perhaps by a somewhat profounder grasp of intellect, or merely (it may be) encouraged and made the most of by a fortunate concurrence of casual conditions. For who shall say what proportion the discovered and acknowledged geniuses of the world's scroll bear to the undiscovered and unacknowledged geniuses who swarm like tadpoles in the board-schools and workshops everywhere around us?

But what makes me above all things skeptical as to the special and exceptional inspiration of the divine genius is a consideration of the historical position of divine geniuses as we actually find them in their own environment. Posterity, divorcing the man from his age, knowing him for the most part as an isolated fact alone, sees him always larger than life, like the heroic statues it erects in his honor. It forgets too often that, in order to judge of him as a unit of humanity, we must look at him in connection with his own surroundings. We are all too apt to personify, or rather to embody and individualize, all great movements: to see in the Reformation nobody but Luther; in the

Revolution nobody but Rousseau and Robespierre and Danton; in the national struggle for American independence nobody but Washington, Jefferson, and Franklin; in the vast movements for the unity of Italy and Germany nobody but Garibaldi, Mazzini, Bismarck, and Von Moltke. But in reality, as the present age now knows well, it is largely the movement that makes the men, not the men that make the movement; and this is true of ordinary epochs as well as of great upheavals, of the thinker and the writer as well as of the soldier, the statesman, and the enthusiast. Take as a very striking example in minor matters Mark Twain. To the English reader Mark Twain is a being more or less unique, or at best he is known as the chief among two or three popular competitors in the field of so-called American humor—Artemus Ward, Josh Billings, and Orpheus C. Kerr being practically his only considerable rivals in the European market. But whoever knows the daily talk and the daily newspaper of Western America knows that embryo Mark Twains grow in Illinois on every bush, and that the raw material of the "Innocents Abroad" resounds nightly, like the voice of the Derringer, through every saloon in Iowa and Montana. A large style of cheap and effective homicidal humor, based mainly on exaggeration and grotesque incongruities, flourishes everywhere on the border-lands of American civilization. The very infants lisp in quaint Western quips, the blushing maidens whisper a dialect which "pans out" rich in the peculiar wit of Poker Flat and the Silverado Squatters. Mark Twain represents but the exceptional embodiment of this extravagant ranching and mining spirit, sedulously cultivated and still further developed by the literary habits of a professional humorist.

In literature and in political life our modern principle of the supreme influence of the environment is now, indeed, universally admitted; it is only in science and in philosophy (where more than elsewhere it is emphatically true) that anybody of authority still doubts it. We all allow that in most matters it is the wave that makes the crest, and not the crest that makes the wave. The old school of critics saw in Shakespeare a dramatic phœnix, solitary of his kind, unequaled and unapproached around or about him. The new school sees in him the final flower and highest outcome of that marvelous outburst which gave us "Faustus" and "Tamburlaine," "Jane Shore" and "Volpone," the "Duke of Milan" and the "Duchess of Malfi." *Primus inter pares* he was, no doubt, but *inter pares* only, not above "a vast dead level of mediocrity." Ford and Webster, Beaumont and Fletcher, Jonson and Massinger stood close beside the throne; Greene and Marlowe had prepared the way beforehand for Hamlet and Shylock and Richard III. The expansion of England in the Elizabethan age necessarily produced the new drama, which showed forth as in a mir-

ror "the very age and body of the time, his form and feature," exactly as the romance of our own day shows forth the stir and ferment and turmoil of the present far greater period of national development. A great deal of what most of us take for Shakespeare is really the necessary spirit and background of the Elizabethan stage, as much the common product of the nation at large and of the dramatic tradition as the modern novel or the modern burlesque is the common product of our own civilization.

In science and philosophy, however, this general principle of necessary development is even more demonstrably true than elsewhere. There comes a crisis every now and then in the evolution of thought, when new discoveries and new inventions are, as we all say nowadays, "in the air"; when numberless workers, led up to a certain point by previous thinkers and previous discoveries, tremble all together on the very verge of the next great generalization or the next important extension of thought or knowledge. "He who says A must say B also," the wise French proverb pithily puts it. Now it sometimes happens in such cases that a number of workers co-operate so much in the new discovery, or the new invention, or the new development, that no one man carries off for himself the honors of the situation. That was the case with the vast physical concept of the conservation of energy, by far the vastest and most fundamental concept ever yet introduced into our view of the material cosmos and its mode of working. Yet that profound law was so slowly evolved by the separate labors of many acute and suggestive thinkers, beginning with Count Rumford and ending with Joule, Meyer, Helmholtz, Grove, Clerk Maxwell, Balfour Stewart, and Tait, that no single name will ever probably be associated with its promulgation, as the name of Newton is associated with the law of gravitation, or as the name of Darwin is associated with the principle of organic evolution. More frequently, however, it happens that a particular worker does either anticipate the others by a decided interval, or succeeds at any rate in attracting to himself the attention of the crowd, and in becoming, so to speak, the eponymous hero of the new conquest. In such cases I do not say that the hero is not really as a rule greater than the men he casts into the shade; but I do say that he is not as a rule as much greater as the world at large, in its love for the sweet simplicity of hero-worship, supposes him to be. It is so hard to distribute your praise equitably between a dozen or more of contributory geniuses; it is so easy to fix upon a single man and declare authoritatively in a very loud voice, "*Ipse fecit!*"

Mechanical inventions show us the working of this popular tendency in a very clear and instructive manner. Who, for example, invented the steam-engine? James Watt, says everybody,

with glib readiness. But those who have looked at the history of the steam-engine know, of course, that there were steam-engines in abundance long before Watt's, and that Watt himself worked deliberately on the basis of Newcomen's model. Newcomen, in turn, had improved on Papin's invention, and Papin perhaps on De Caux's, and finally on Hero's. Now, nobody denies that Watt was a very great engineer; if he had never invented the double-acting engine at all, indeed, he would have been remembered among the mechanical geniuses of the world by his numerous other improvements and discoveries; but he was not so absolutely supreme and unique as the popular fancy has made him out to be. Indeed, taking into consideration the date of its construction, Newcomen's engine was a much more remarkable triumph of human ingenuity that James Watt's. But Watt introduced the final details which rendered steam a power in the world, and with him accordingly rest the popular suffrages as "the inventor of the steam-engine." Similarly, who invented the locomotive? George Stephenson, says everybody, as before. But those who have looked at the history of the locomotive know, of course, that both locomotives and railways existed in plenty before Stephenson's, and that the Rocket was merely the most successful competitor among many contemporary competitors for public favor. Nobody denies George Stephenson's marvelous native engineering abilities; on the whole, taking into consideration his humble beginnings, he seems to me more of a heaven-born genius in his own way than almost anybody else with whose history I am acquainted. But the work he did upon the locomotive was adaptive and developmental, not original and novel. The great invention did not spring in full panoply—like Athene from the head of Zeus—out of any one engineer's profound brain; it grew slowly, piece by piece, like everything else, from a hundred men's co-operating intelligences.

Like everything else, I say deliberately, for it is the same with every great invention. Look at the telegraph, so hotly debated between Morse and Wheatstone; look at the telephone, equally divided between Edison and Bell; look at photography, whose several stages owed so much successively to Wedgwood and Davy, to Niepce and Daguerre, to Talbot and to Archer. "Great discoveries," says Prof. Fiske, with evident wisdom, "must always be concerned with some problem of the time which many of the world's foremost minds are just then cudgeling their active brains about." It was so with the discovery of the differential calculus and of the planet Neptune; with the interpretation of the Egyptian hieroglyphics and of the cuneiform inscriptions; with the undulatory theory of light and the mechanical equivalent of heat; with the nebular hypothesis and with spectrum analysis. In some cases

one man has borne off all the praise, while many men bore the brunt of the labor; in other cases the work done has been so evenly distributed among several laborers that even that unjust judge, the general public, could set none as greater or less than another, none as before or after another.

Observe, once more, a case where, at first sight, the part played by the individual genius seems exceptionally great—I mean Newton's discovery of universal gravitation. Here, surely, if ever anywhere, the genius was fully entitled to say, "Alone I did it." Yet even here it was quite as much the crisis that made Newton as Newton that made the crisis. Galileo's observations on the pendulum, Torricelli's invention of the mercurial barometer, the true theory of the common pump, Von Guericke's air-pump, Copernicus's view of the solar system, Kepler's laws of motion—all these led up, slowly but surely, by various routes, to the ultimate and inevitable discovery of the law of gravitation. The world had its problem then and there neatly presented to it. The Cartesian theory of vortices, indeed, was a premature attempt at a metaphysical, or at least an *a priori* solution of the self-same difficulty. All the early work of the seventeenth century led up directly to Newton as a foregone conclusion. Newton himself merely came, in the fullness of time, as the great, fully-equipped mathematical and physical thinker who could not fail to advance science by that one step, already foreshadowed and predestined for him by the joint work of his many predecessors.

So it was, too, with organic evolution and with evolution in general. In the last century De Maillet and Monboddo, from different sides, had caught faint glimpses (as in a glass, darkly) of the descent of animals from common progenitors. With Buffon the glimpse became a distinct idea; with Erasmus Darwin the idea grew into a fully evolved and tenable hypothesis. Lamarck gave it form and body; Goethe breathed into it a wider cosmical spirit. Even the particular notion of natural selection was hit upon simultaneously by Wallace and Darwin; while Spencer had traced out the development of mind seven years before the publication of the "Origin of Species." Kant and Laplace and Lyell led on, by many lines, to the "System of Synthetic Philosophy." Evolutionism has been a growth of numberless minds, yet in the future it will appear to the multitude at large as the work of two men, and of two men only—Charles Darwin and Herbert Spencer. I need hardly say, I hope, that no man feels more profound reverence for those two mighty thinkers than I do—indeed, I dare never trust myself to say in public how profound that reverence really is; we stand so near them still that those who estimate them at their true worth only get laughed at; but I do not think we ought ever to forget the important part played also in their

great revolution by so many other able thinkers and workers, whose names will never survive into future ages.

Every now and then a great crisis occurs in the world's history when some new advance, rendered inevitable by the slow growth of the past, halts for a moment on the threshold of realization. A genius is needed to make the advance; but the genius is always then and there forthcoming from the vast reservoir of potential greatness forever present in all civilized countries. It is the noble chance that brings forth the noble knight: the men lucky enough to take the tide at its flood, lucky enough to reach maturity at the very moment of the turn, achieve a visible success perhaps somewhat disproportioned even to their real and undoubted merit. Or rather, they throw unduly into the shade the men who precede and the men who come after them. There are moments when good workers can not fail to obtain wonderful results, because those results are then and there almost forced upon them by the circumstances of science. There are moments when good men must almost of necessity become hewers of wood and drawers of water for the architectonic generation that will come after them, because the last generation has built up all the materials then available, and new stores must needs be collected before another story can possibly be added to the whole vast fabric of scientific thought. Every mighty outburst is followed close by an apparent lull, a lull during which the forces at work are expending themselves rather upon preparation than upon actual performance, upon providing fresh facts and hypotheses and suggestions rather than upon co-ordinating and interpreting the old ones.

Hence it may often happen that certain names, popularly regarded as small, may really belong to greater individualities and greater intellects than certain other names of critical and, so to speak, nodal interest. The man who comes at the exact turning-point performs in one sense a greater work than the man, however able, who chances to light upon one of the ebb-tides or intervening periods. Geology supplies us in our own day with an excellent example. Lyell's name will always be held to typify the evolutionary impulse in geology, as Darwin's does in biology, Spencer's in psychology, and Laplace's in astronomy. But of these four central names, Lyell's stands distinctly on a much lower mental level than the remaining three. On the other hand, we have now among us a geologist of the very highest ability, a man who has devoted to his chosen science a breadth and profoundness of cosmical grasp never before associated with it—I mean, of course, Archibald Geikie. It is impossible for any competent critic to look at Geikie's "Text-Book of Geology" by the side of Lyell's "Principles and Elements" without immediately recognizing the immense difference of mental stature between the two men. I do

not mean merely that Geikie's work is fuller and more all-sided than Lyell's; the growth of the science and the accumulation of materials would alone suffice amply to account for that. But the lucid, orderly, and masterly arrangement, the just sense of method and proportion, the logical even development of the subject, the judicial temper, the cosmic vision, the rare combination of profound depth with perspicuous clearness, all alike place Geikie's remarkable book on a far higher level than his famous predecessor's. Yet I do not suppose Geikie's name will ever become as popularly celebrated as Lyell's. The lesser man happened upon the apter moment: he did fairly well the task he had it in hand to do; and the crisis itself more than sufficed to make him and his work conspicuous forever.

Genius, then, I humbly hold, differs from "mere talent" only in one or other out of three particulars: either it is talent of a higher order, backed up by industry; or it is the same talent, made notable by opportunity; or it is talent, often of a low grade, redeemed by exceptional originality, or combined with some piquant and arresting touch of quaintness, oddity, or it may even be grotesque deformity.

This is a democratic age—an age of socialism, of co-operation, of the revolt of the masses against the few and the privileged. We have found out in our own time that all wealth is the creation of the many: that Rome was not built in a day; that the railways, roads, canals, rivers, mines, factories, warehouses, machines, and towns of modern England, were slowly exploited by the continuous labor of thousands upon thousands of skilled workmen. We have found out that generation after generation has helped to build up our cathedrals and castles, our mills and looms, our ships and steamers, our commerce and manufactures. We know that the electric telegraph goes back at least to Gilbert's researches into magnetism in Queen Elizabeth's days; that the steam-engine goes back to the Marquis of Worcester in Charles the Second's reign; that ironclads and revolvers are not things of yesterday; that every art and every invention, though it may have its own eponym in modern times, is the joint creation of innumerable nameless and successive workers through a hundred generations. The Great Man theory has broken down, and has been replaced by a belief in Great Movements. I wish here to reclaim in the same way on behalf of the wider democracy of talent as against the exclusive oligarchy of genius. The language, the vocabulary, the idiom, the eloquence, the thought of every age is molded by a thousand unknown speakers and writers who each contributes his own part to the grand total of the literature of the day. From the lowest to the highest the gradation is regular, even, and continuous: there is no break; there is no gulf; there is no isolated

peak of solitary grandeur. Here and there individuals rise a little above the mass, and form as a whole the body of thinkers. Here and there individuals rise a little above the body, and form as a whole the smaller group of men of talent. Here and there individuals rise a little above the group, often in the merest details of their personal idiosyncrasy, and attain more or less distinctly to the level which most of us recognize as genius. But from first to last the various stages of intellect or of special faculty rise gradually one above the other; the differences between the men themselves are minute; it is the differences between the effects produced upon others that elevate some on so high an imaginary pedestal above their fellows.

I know that to say all this may look invidious. I know that the polite crowd of clubs and drawing-rooms, which can not see the importance of a psychological question for its own sake, apart from personalities, will read in it throughout nothing but envy, hatred, malice, and all uncharitableness. However, on that point I am not afraid. I don't think any man living has a profounder respect than I have for the genius of Matthew Arnold, and William Morris, and Herbert Spencer, and George Meredith. I'm sure no man living has a more generous appreciation than I have for the genius of Andrew Lang and Austin Dobson, of James and Howells, of Robert Louis Stevenson and Walter Besant. I know that genius simply swarms among us; that in this age one may see such men as Croll wasting, like spendthrifts, upon a solitary problem of the glacial epoch, vast constructive and organizing powers which in any other age would have secured them world-wide fame and reputation; such men as Beddoe, working for pure love, with inexhaustible industry, through a whole lifetime, at questions which everybody else ignores and neglects; such men as Galton, filled to the brim with ingenuity, acuteness, and insight, till it oozes out at their finger-ends, pouring forth in abundance upon an unheeding world the suggestive results of their piercing, keen, and all-sided thinking. I know that genius is choking and strangling itself in the keen struggle for recognition and consequent usefulness. But I know also that if genius is a drug, talent is a weed in modern London; and that talent too deserves its due honor. Men of ability throng thick around us—men of ability so exceptionally high that in any less richly gifted age than ours it would be universally recognized and crowned as genius. The commoner such talent becomes in the world the more supereminent must be the powers, or the more peculiar the twist, or the more marked the originality which will suffice to raise it into the higher category. In other words, what is talent to-day would have been genius yesterday; what is genius to-day will be but talent as men reckon to-morrow.—*Fortnightly Review.*

INVENTIONAL GEOMETRY.

By EDWARD R. SHAW,
PRINCIPAL OF THE YONKERS HIGH-SCHOOL.

INVENTIONAL geometry is the name given to a series of carefully graded problems, thought out and arranged by that able mathematical teacher, William George Spencer, the father of the distinguished philosopher.

The little book was published in this country in 1876.* An appreciative review in the New York "Evening Post" led the writer to procure a copy, and then to set to work to solve the

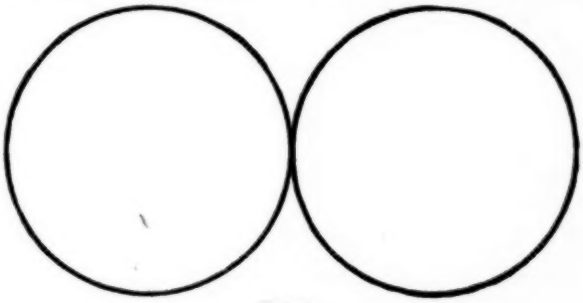


FIG. 1.

simple problems in the order given—the purpose being to form an impartial judgment of the value of the book for school use. A hundred or more problems were wrought, with increasing interest; and then, to make a further test, the book was given separately to a number of pupils, both girls and boys, each being

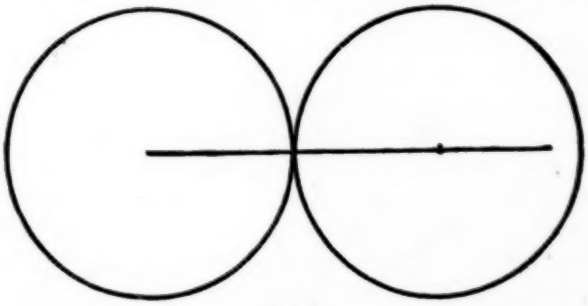


FIG. 2.

asked to work as many problems as he could. In each instance the pupil became interested in the work, and wished to continue. The remark of one girl was especially significant. "It's so different from ordinary study," she said; "there's something about it that leads me on."

A class was formed after these tests, and a few months' work

* New York, D. Appleton & Co., 1876.

proved the incalculable value of inventional geometry in a school course of study; and eleven years' experience in many classes and in different schools confirms that judgment.

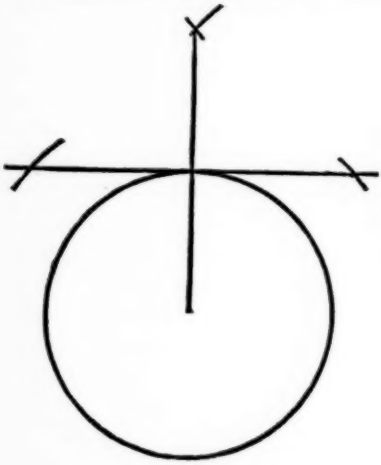


FIG. 3.

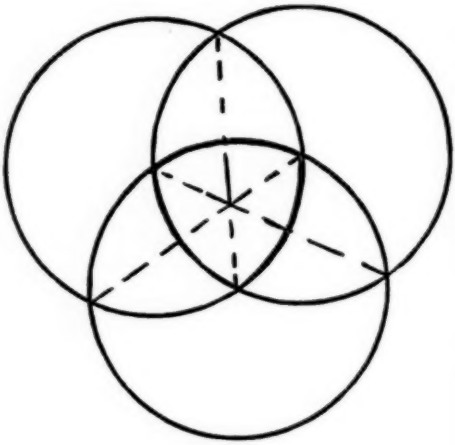


FIG. 4.

In all these classes the pleasure experienced in the study has made the work delightful both to teacher and taught; and there has always been a continuous interest from the beginning to the end of the term. This pleasure and interest came, not from any

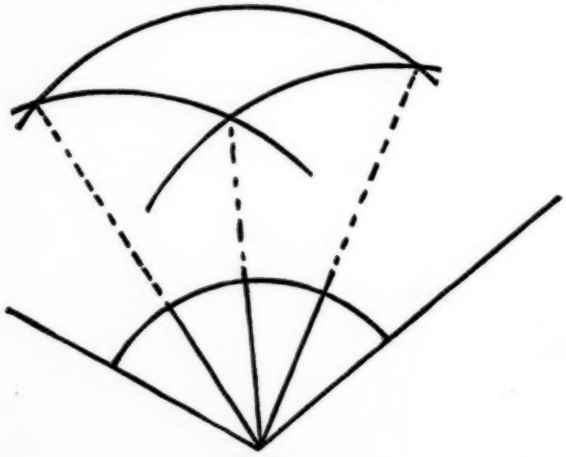


FIG. 5.

environment, not from the peculiar individuality of the class, but because the problems are so graded and stated that the pupil's progress becomes one of self-development—a realization of the highest law in education.

The accompanying illustrations of the work of one class,*

* The average age was about fourteen years. The illustrations are reproductions of drawings made by the class, though in the usual class-work the lines would be finer.

which began the study in September of the past school year and continued it till February, afford some suggestion of the scope of inventional geometry. Each pupil is equipped with a ruler, which he uses merely as a straight-edge, a pair of drawing-compasses, and a right-line pen. For a short period drawings are made with lead-pencil, till the pupil has acquired a little manual skill; then the change is made to pen, and all problems must be drawn in ink. Neatness and accuracy are insisted upon, and secured.

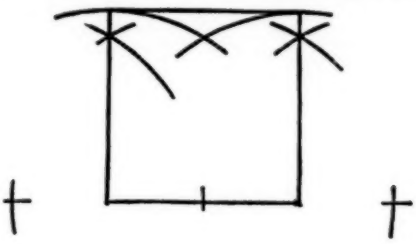


FIG. 6.

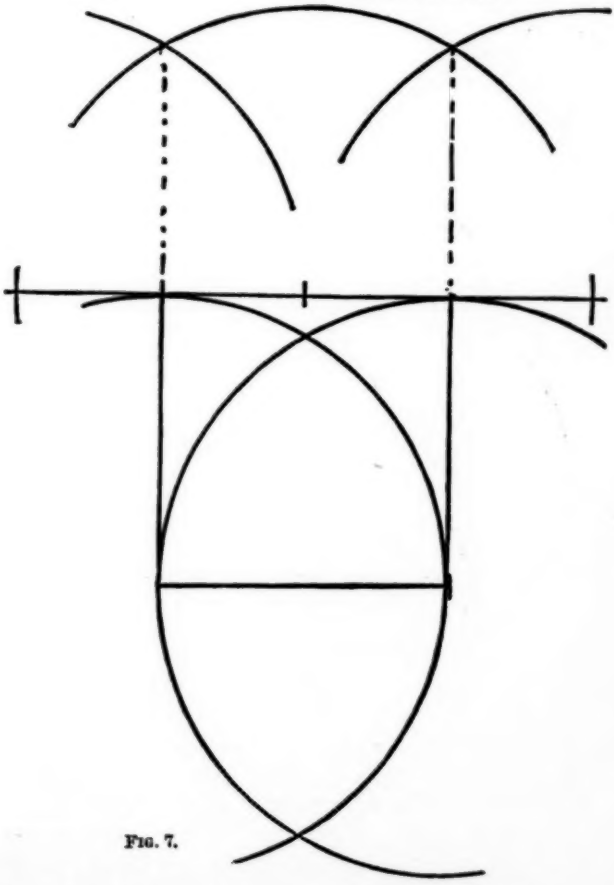


FIG. 7.

The class, having worked at their desks the problems assigned for a lesson, come up for recitation, and are directed to put their

solutions upon the blackboard. The problems admit of such graphical representation on the board, and there are always so many different forms of solution, that pupils delight in this bold

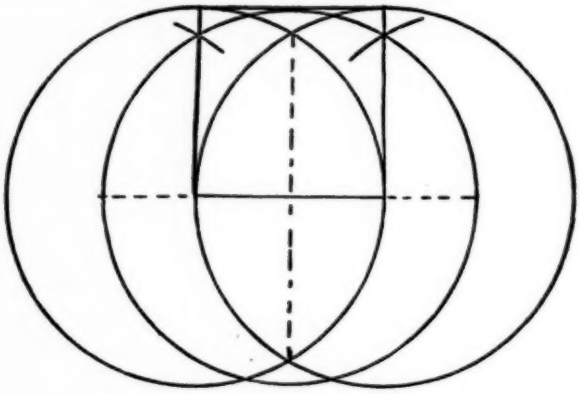


FIG. 8.

drawing of what they have wrought out at their desks. Explanation follows the drawing, in which the pupil accounts for each step and every point he has used in constructing. At the start

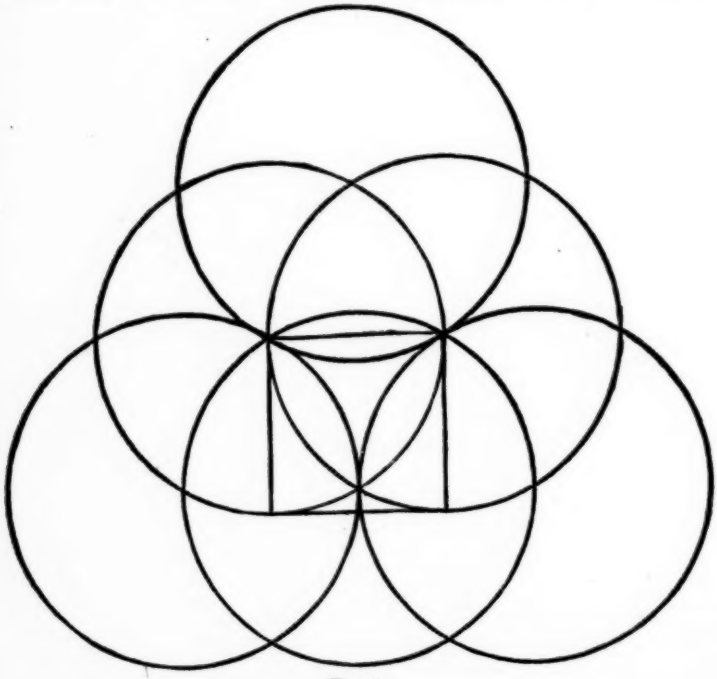


FIG. 9.

he does not see what points he may take, nor what are given. For instance, the simple problem, "Can you place two circles to touch each other at a particular point?" will likely be drawn as shown

in Fig. 1. The question, "Where was the particular point?" or, the point being marked, where he must make the circles touch, brings the correct solution (Fig. 2).

Many mistakes of like nature occur in the first lessons. In every such case the pupil must be led, by questioning, to see what is incorrect. He should not be told or shown, but thrown back upon himself; for, in inventional geometry, the knowledge is to be gained by growth and experience, through the powers he possesses and the method of acquirement peculiar to his mind. Occasionally the pupil is not a little baffled, and the skill of the

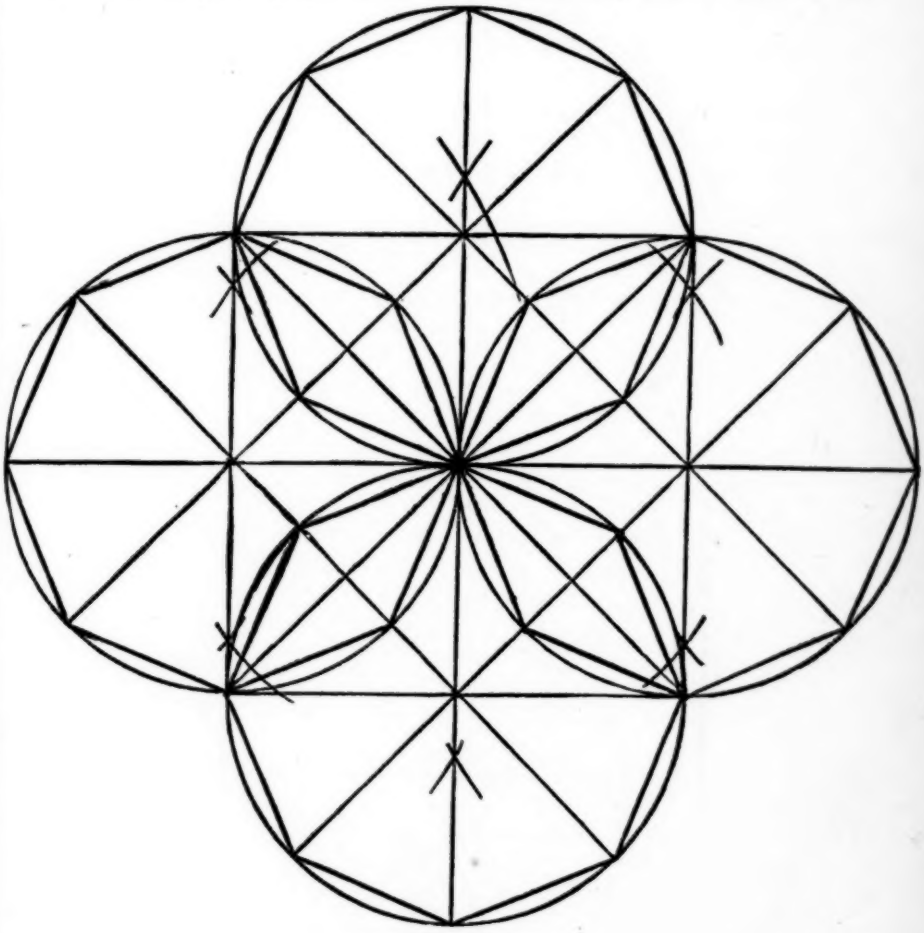


FIG. 10.

teacher is put to its best test to gain the solution without showing or telling him. Telling or showing is the method of the instructor—not of the teacher. The following problem (Fig. 3), "Given a circle, and a tangent to that circle, it is required to find the point in the circumference to which it is a tangent," is one of

these difficult ones. Not many of these occur; the author, however, has a purpose in these few. For the most part the pupil is able by the grading to go on without questioning, as will readily be seen by examining the problem of which Fig. 4 is the solution, and the questions based upon it:

"Place three circles so that the circumference of each may rest upon the centers of the other two, and find the center of the curvilinear figure which is common to all the three circles."

"That point in an equilateral triangle which is equally distant from each side of the triangle, and equally distant from each of the angular points of the triangle, is called the center of the triangle."

"Can you make an equilateral triangle whose sides shall be two inches, and find the center of it?"

"Can you place a circle in an equilateral triangle?"

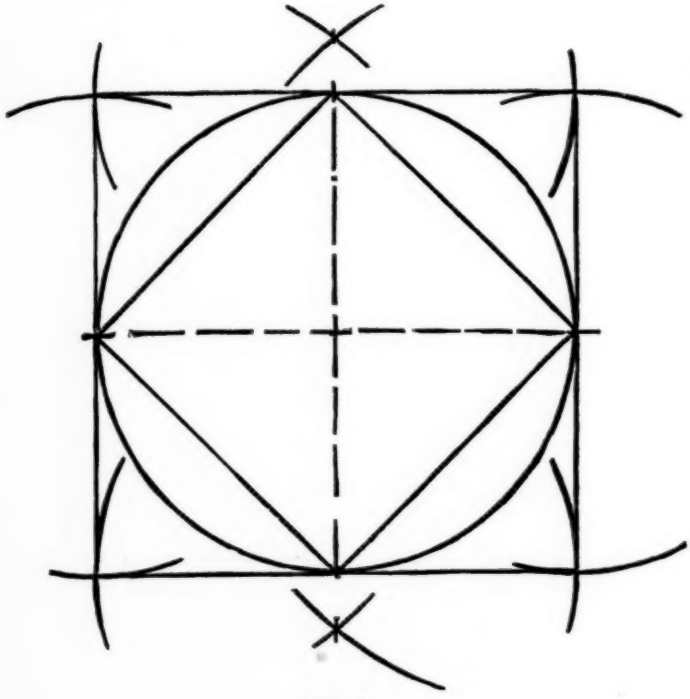


FIG. 11.

"Can you divide an equilateral triangle into six parts that shall be equal and similar?"

"Can you divide an equilateral triangle into three equal and similar parts?"

To exercise to the utmost the pupil's power to invent, problems are given with certain restrictions: "Can you divide an angle

into four equal angles without using more than four circles?" (Fig. 5).

"Can you construct a square on a line without using any other radius than the length of the line?" (Figs. 6, 7, 8, and 9).

Such problems as that solved in Fig. 10, "Can you place four octagons to meet in one point and to overlap each other to an equal extent?" delight the eye by beauty of form, and teach the pupil the basis of geometrical design.

Figs. 11 and 12, solutions to "Can you fit a square inside a circle, and another outside, in such positions with regard to each other as shall show the ratio the inner one has to the outer?"

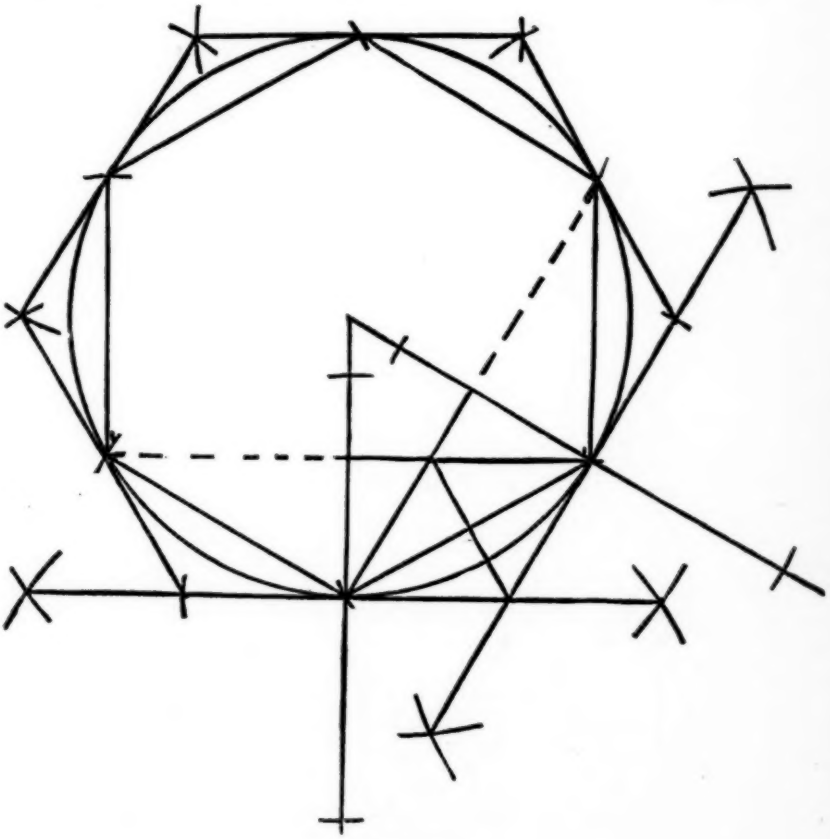


FIG. 12.

and "Place a hexagon inside a circle, and another outside, in such positions with regard to each other as to show the ratio the inner one has to the outer," illustrate one way in which comparative area of figures is treated.

We have spoken of the pleasure a class experiences in putting their solutions upon the blackboard, and in examining the draw-

ings of each other and following the explanations. There continually come up at these times incidents of this sort: Fig. 13 is given as a solution of "Can you raise a perpendicular to a line, and from the end of it?"

In his explanation the pupil points out the given line, the end from which he is to erect the perpendicular, the point from which as a center he sweeps each circle, why he may take that point, and

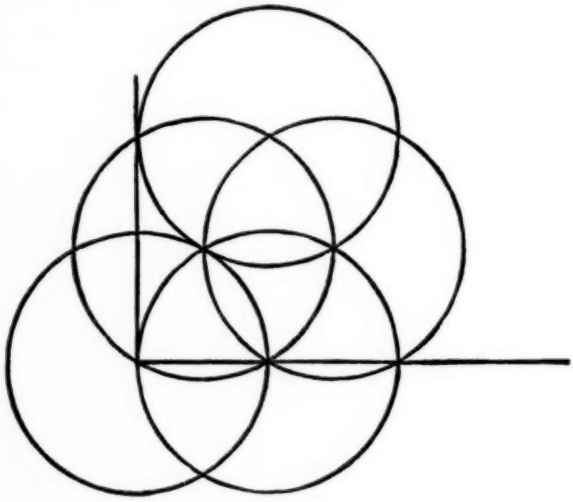


FIG. 13.

why he sweeps the circle. Another pupil discovers, before the explanation is finished, that the problem can be solved with one less circle, and there is the keenest interest while he draws and explains his way (Fig. 14).

The original and independent power acquired is shown in Figs.

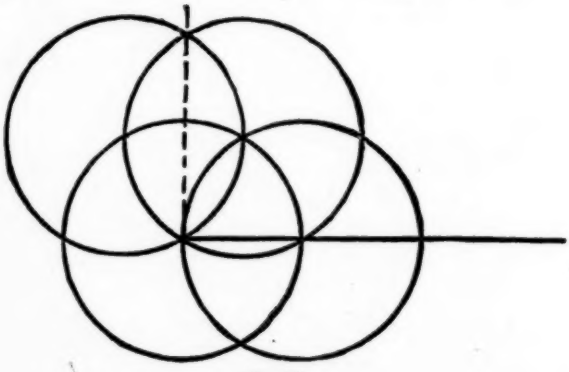


FIG. 14.

15, 16, 17, and 18, solutions of the problem, "Can you make an octagon with one side given?"

Spencer's "Inventional Geometry" is one of the most original

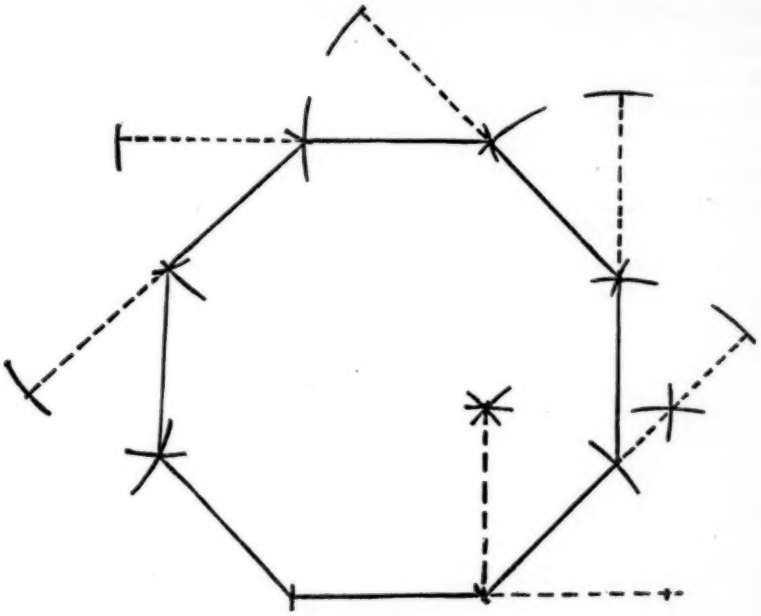


FIG. 15.

and scientific contributions to school text-book literature ever made. What this little book teaches simply and naturally was

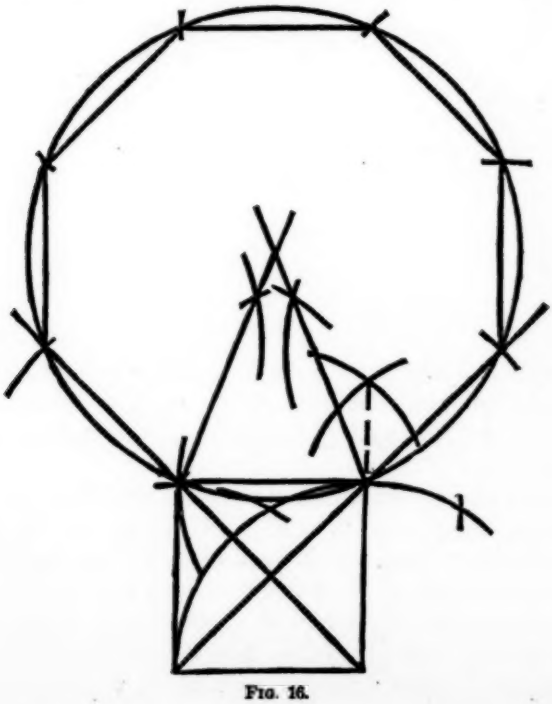


FIG. 16.

taught by going over demonstrative geometry, then taking up mechanical drawing, and adding to these personal experience. The author has secured all this and much more. He appeals first to the inventive faculty, seeks expression through the hand, and brings before the eye accurate and beautiful forms of the pupil's own constructing. The eye is trained to accuracy and similarity of forms, invention is quickened, comparison and judgment are constantly exercised, and inductive growth of mind is directly promoted. Besides the manual skill gained in constructing figures, and the power acquired to deal with original ques-

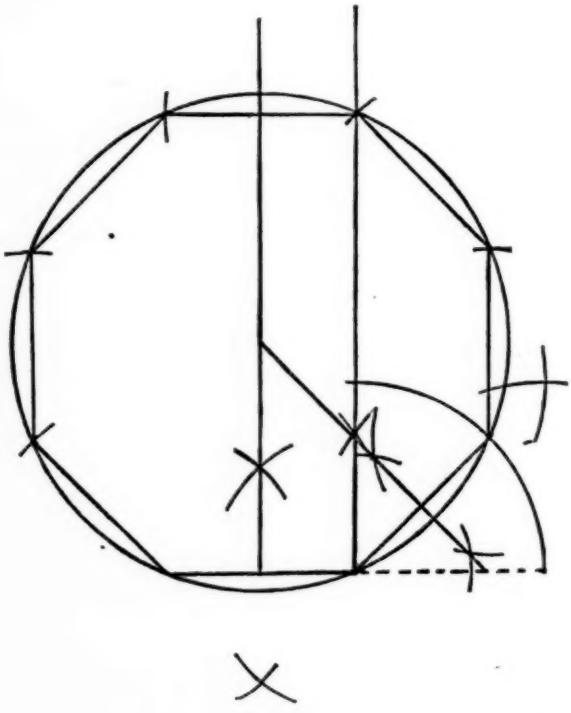


FIG. 17.

tions through the constant appeal to invention, the pupil gains by his own efforts proofs of theorems really conclusive in themselves, though not the syllogistic form of proof belonging to the deductive science.

In but one of a great number of schools visited has the writer found inventional geometry used, and in that school quite out of the design of the author. It should precede demonstrative geometry, so as to give the pupil many concepts to draw upon when he takes up syllogistic demonstration. Demonstrative geometry then becomes an easier subject, and he is surer of what he is doing, because he has more general notions as a basis. In the school alluded

to, the pupils were constructing figures and then demonstrating the questions, making the study simply supplementary to ordinary geometry. There was little invention. Nearly all the constructions were noticeable adaptations of what had been drawn for demonstration in the deductive study.

Nor have the advocates of industrial training, with but one exception, so far as the writer has been able to learn, availed themselves of this study, which is not tentative, but directly in the line of what they urge.

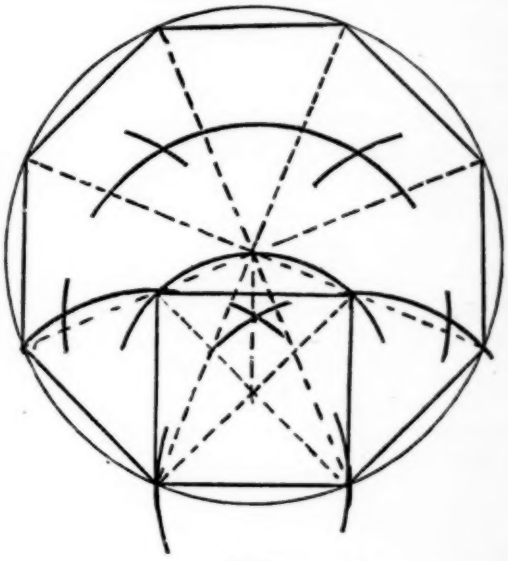


FIG. 18.

Inventional geometry should be given a place in every school; and, if it becomes a question of time between that and demonstrative geometry, assign the time, in nearly every instance, to the former, because it is of far greater practical value, and many times more educative.

SCIENCE AND ITS ACCUSERS.

BY W. D. LE SUEUR.

NOT many months ago we had in a single number of a leading English review—the "Contemporary"—no less than two articles by able writers lamenting the disintegrating action of science on morality and religion. The first of these was from the pen of the eminent Belgian publicist, M. Émile de Laveleye, and was entitled "The Future of Religion"; the second, contributed by Miss Frances Power Cobbe, dealt in a trenchant and aggressive manner with "The Scientific Spirit of the Age." Both writers seem to be strong anti-Darwinians; but both attack the Darwinian doctrine, not on scientific grounds, but on account of its alleged incompatibility with views and sentiments which they regard as of pre-eminent importance. The only relevant criticism, however, that can be directed against a scientific doctrine is one intended to show that it is not what it claims to be—

that it is not scientific—that it has no proper place in the scheme of our acquired and organized knowledge. If a scientific opinion is not established, if it is not demonstrated beyond all possibility of cavil, why concern one's self about it, except to invalidate the claims that may have been wrongly put forward on its behalf? To discuss its bearing on religion is merely to suggest that it is true, but that "pity 'tis 'tis true," and to offer a premium to weak souls to try to persuade themselves that it is not true. If a doctrine is true, and yet inconsistent with a certain theological scheme, what is going to be done about it? Will whole books of lamentations nullify it? Will it be disproved by the most diffuse argumentation designed to show that, if it holds its ground, something else will have to give way? Of course it will hold its ground if it is true; and of course whatever is inconsistent with it must give way, and the world must adapt itself as best it can to the change.

But let us consider in detail some of the accusations brought against modern science and its professors by the critics whose names we have mentioned. "Darwinism," says M. de Laveleye, "applied to social sciences, sets aside all notions of equality, and simply glorifies the triumph of the strongest and the cleverest." Darwinism is properly a form or phase of biological doctrine, and as such does not glorify anything particularly. Even in the realm to which it strictly applies there is no glorification of natural selection, merely a recognition of the fact that natural selection is an active agency in the production of results that come under our observation. The only possible application of Darwinism to "social sciences" would lie in a close examination of social phenomena, in order to see whether there also a principle of natural selection might be found to be at work. In this sense Darwinism may be said to have been applied to the social sciences, and with good results so far as our comprehension of social phenomena is concerned. But is it a sin to understand social phenomena? In all other departments of observation we esteem it a great advantage to get on the track of Nature's operations, to be able to follow her secret processes; and it is really difficult to see why we should debar ourselves from understanding, as far as it may be given to us to do so, the course of things in the social order. The true Darwinian does not seek to impose a law on things—he leaves that to his theological censors; he is content to discover law *in* things. There is simply no sense, therefore, in talking of the Darwinian exulting in force, or glorifying "the triumph of the strongest and the cleverest." At the same time it may be remarked that it is hard to understand how, except by some very special and extraordinary interposition of Providence, "the strongest and the cleverest" are to be prevented from triumphing; and upon the

whole it seems a more natural, and indeed beneficial arrangement, that the "strong and clever" should dominate the weak and stupid, than that the weak and stupid should dominate the strong and clever. We doubt whether Nature will wait for the approval of the Darwinian or of any one else before giving, as a general thing, the race to the swift, the battle to the strong, and wages to the man who can earn them.

The Darwinian is accused by the Belgian philosopher of holding that "charity and pretended justice interfere very wrongly" when they seek to prevent stronger races and individuals from usurping the place of weaker ones. The Darwinian takes up no such absurd position. He is an observer of nature, we can not too often repeat, and not a lawgiver. As an observer of nature he perceives that physical strength divorced from intellectual strength is ineffectual, and, in the struggle for life, hardly to be distinguished from weakness. He observes further that intellectual acuteness divorced from moral sentiment overreaches itself, and becomes a kind of stupidity. From multiplied observations of this nature he forms a truer idea, probably, than any mere *a priori* reasoner as to the forces which rule the world now, and as to those which will be chiefly dominant in the future. He is not opposed to any charity that, in his judgment, tends to make men better; but he could not be a man of any sense if he were not opposed to much that calls itself charity. As to justice, he sees in it the expression of a social force, which has its origin in the fact that society is an organism, the general life of which reacts upon any abnormal manifestations in special members or organs. Far from its being true that justice "stands in the way of the application of natural laws," justice may be said to be a striking illustration of the great natural law or axiom that the whole is greater than the part. To abandon justice would be to place all social order at the mercy of individual caprice; in other words, it would be the suicide of society.

We are next treated to an imaginative sketch of what the world would be like in the absence of all religion: "There is no God and no immutable type of truth and justice." Just how the persuasion that there is no God is going to take possession of mankind is not explained, whether through the utter breaking down of the evidence upon which the doctrine of a Divine Being has heretofore been believed in, or through some further progress of philosophical speculation. One is tempted to ask, however, what the critic really wants. Are there certain doctrines which he wishes to shield from criticism? If so, why not say so distinctly? Why not say in plain terms that mankind has, in some way difficult to explain, got possession of certain opinions or convictions of inestimable value, but which can no more bear exami-

nation than a soap-bubble can bear handling, and that therefore these must, at all costs, be protected from every breath of criticism? If this is not what is meant, if, on the contrary, it is maintained that the being of God is a luminous truth, proclaiming itself in the very heart of man, why not challenge all the philosophies of the world to assail it at their peril? Why not say to Darwinians and all others: "Push your researches as far as you like; make your most comprehensive inductions, your widest generalizations; construct your most daring theories: not only will nothing impair this great central truth of Deity, but all the truths you gather will lack significance till illuminated by it"? But, strictly speaking, the Darwinian theory has nothing to do with the question as to the existence of God. It is no more atheistic in its nature than the Newtonian theory of gravitation. The latter substituted for the *angeli rectores* of Kepler an all-pervading law of matter; and Darwinism substitutes for certain supposed acts of spasmodic creation an orderly sequence of development; but neither one nor the other professes to say how the origin of the universe should be conceived. If Darwinism has weakened the argument for theism in certain minds, it has strengthened it in others—witness the recent address of Mr. Balfour on "Positivism," before the Church Congress at Manchester.

We are threatened with the destruction of an "immutable type of truth and justice"; but what is the exact meaning of these words? If truth is the conformity of statement to fact, how can the idea of truth ever vanish from the world? Certainly, if such a result should ever come about, it would not be due to the influence of any honest form of scientific thought. We do not think any one will say that Mr. Darwin did anything in his long lifetime to weaken respect for truth, or to make truth less a reality in the world. We know some people whose efforts do tend strongly in that direction; but, for the most part, they are not Darwinians; they are people who can not bring themselves to define the terms they use, and who try to make authority do the work of demonstration. So successful, unfortunately, are teachers of this class, that throughout a large portion of society—the portion in which Darwinism is very generally flouted and scouted—a sense for truth in intellectual matters is most conspicuously lacking. As to an "immutable type of justice," does any one know what that means? Can any one conceive what an immutable type of justice would be like? How would it be expressed? In an act? We can either now conceive an act that would serve as an immutable type of justice, or we can not: if we can, then the type is safe; if we can not—which we imagine is the truth—then we must forego the hope of an immutable type, and content ourselves with what perhaps is good enough

for us—relative justice—such justice as will serve our need from day to day.

Another threat held out is the miserable condition to which human life would be reduced if faith in a future life should disappear—a result that Darwinism is credited with hastening. Let us talk seriously on this subject. If there is evidence of a conscious life for human beings beyond the grave, Darwinism surely can not overthrow it. It may possibly be that heretofore the doctrine of immortality has been taught on very insufficient grounds, and that Darwinism has so far awakened the popular intelligence that the insufficiency has become apparent; but, if so, Darwinism is not to blame. It is simply a question of repairing the breaches in a damaged argument. A true doctrine does not need false supports; on the contrary, no greater service can be rendered to a true doctrine than to throw it back on its legitimate proofs. So far, therefore, as this or any other doctrine is true, Darwinism can only establish it the more firmly by taking away the insecure foundations on which it may provisionally have rested. The question is worth raising, however, whether the invalidation of this theory of a future life—not that we see how Darwinism as such is going to accomplish such a result—would have so disastrous an effect as M. de Laveleye assumes upon human happiness. He imagines some one addressing the toilers of the world, and bidding them, as "there is no compensation elsewhere," to raise their heads, "too long bent to the dust beneath the yoke of tyrants and priests." Is it possible that so distinguished a liberal as M. de Laveleye wants to join himself to tyrants and priests in their endeavors to hold down the working-classes by the promise or the lure of "compensation elsewhere"? Compensation for what? For injustice? But if the next world is to make amends for the injustices of this, then why lament over what the people might do if they rose against the holders of wealth? At the worst they could only work injustice, and the next world will make amends for all that. Why should not next-world sauce, that is found so admirably adapted for the laboring-man goose, be equally suitable for the capitalist gander? But if it is not injustice, but merely misery, for which a compensation is to be found in a future life, the lesson to be learned, we presume, is that the miseries of this life are to be endured in a patient spirit, and that no particular effort need be made to redress them here and now. But how all this talk about a future life tends to confuse our ideas and paralyze our activities in dealing with present interests! Instead of trying to administer an anodyne to those who suffer by holding out promises of future enjoyment, we should be far more disposed to tell them that their right and duty is to make the best of this world; and

that the best will be made of it by studying and conforming to the conditions on which happiness depends—the conditions that make for the general improvement of life, physical and social. To speak plainly, it seems to us a very mean business for those who occupy positions of vantage in this world to preach compensation in another world to their less favorably situated brethren, in order to make them contented with their lot here. The sooner the calculations of all men are placed on a present-world basis, the better it will be for every important human interest.

But we are told that, not infrequently, "with religion morality also disappears"; inasmuch as "science, when reduced to material observation, can only know what is, not what ought to be." What is meant by reducing science to "material observation"? Science, we take it, observes all that can be observed; and we are not aware of any proposition to cut science off from any field in which observation is possible. If science—in the broadest sense—can not teach us what ought to be, what can? The fact is, that "what ought to be" depends in the most intimate manner on what is; so that, the more perfectly one knows what is, the more clearly he discerns what ought to be. Let any intelligent man examine himself, and say whether any sense of obligation he has does not directly result from some knowledge he possesses of what is. "The denial of the spirituality of the soul," says our philosopher, "uproots all reasonable motives for being just and honest." But supposing that one religiously refrains from either affirming or denying a proposition the terms of which he can not understand, is there any obstacle to his being just and honest? We trow not; and this attitude of mind, we fancy, is that which characterizes most thinkers of the Darwinian or evolutionist school. But why any speculative opinion on the nature of "the soul" should stand in the way of anybody's honesty, it is hard to understand. If the opinion, whatever it may be, has been honestly arrived at, and is honestly held, that simple fact will be a guarantee to some extent for honesty in other matters. It is not difficult to find people whose views about "the soul" are quite unexceptionable from the orthodox point of view, but whose daily practice is far from exemplifying a high type of honesty and justice. "Duty without God or a future life," we are sententiously informed, "is a very fine word, but it has no meaning whatever." Alas! what meaning has it with many of those who profess the strongest belief in these doctrines? We should like to ask M. de Laveleye and others who talk in this fashion whether, on the strength of their own experience, they can affirm that theological unbelievers as a class are morally inferior to believers. The fact is, as we believe, that the average of morality in the so-called orthodox world is very

poor, and that it will continue to be so until a new element is introduced into it from the scientific study of nature, the element of intellectual honesty. It is easy to make such statements as that, "if all religious feeling were to melt away, a return to primitive barbarism would be inevitable," but to prove them might not be so easy. It may be remarked that primitive barbarism has always been marked by strong religious feeling as well as by comprehensive ignorance; and, therefore, if we succeeded in getting back to primitive barbarism, we should have reached a fine starting-point for another religious evolution. M. de Laveleye, however, does not expect that things will get to this pass; his idea is that our future civilization will be presided over by a purified form of Christianity based upon the most elevated teachings of its Founder. What the future of Darwinism will be he does not tell us—whether it will vanish from the earth like an exhalation, or mingle with and perchance support the new creed. If the former is to be its destiny, we should have some hint as to the probable manner of its going; if the latter, it is hard to see why it should have been made an object of attack.

Miss Cobbe, who discusses "The Scientific Spirit of the Age," admits that she does it "from an adverse point of view." The "epoch-making biography of Mr. Darwin," containing his "admirably candid avowal of the gradual extinction in his mind of the æsthetic and religious elements," has, she thinks, "arrested not a few science-worshipers with the query, What shall it profit a man if he find the origin of species and know exactly how earthworms and sun-dews conduct themselves, if all the while he grow blind to the loveliness of nature, deaf to music, insensible to poetry, and as unable to lift his soul to the divine and eternal as were the primeval apes from whom he has descended?" Miss Cobbe hastens to show that, for her own part, she has not sacrificed everything to science, by making a few remarks in a very unscientific spirit on the effects of scientific study. It promotes, she tells us, practical materialism. The student of science will—we quote the actual words of this once highly rational and thoroughly liberal-minded writer—"view his mother's tears not as expressions of her sorrow, but as solutions of muriates and carbonates of soda, and of phosphates of lime; and he will reflect that they were caused, not by his heartlessness, but by cerebral pressure on her lachrymal glands. When she dies, he will 'peep and botanize' on her grave, not with the poet's sense of the sacrilegiousness of such ill-placed curiosity, but with the serene conviction of the meritoriousness of accurate observation of the flora of a cemetery." What are we to say of this if not that it is unmitigated trash? Is it known that home affections are less powerful

or less sacred in scientific than in unscientific households? Is there even ground to conjecture that such is the case? If not, such language as the above simply shows that Miss Cobbe, who has written so much and so well in times past, is growing hysterical at the very period of life when we might have expected to see her manifesting in a special degree the qualities of moderation and self-control, of calm insight and wide sympathy.

Miss Cobbe objects to the scientific spirit that it makes much of disease and little of sin. If so, it is simply inverting the habit of past times, which was to make much of sin and little of disease. And what was "sin" in the apprehension of our ecclesiastically-directed forefathers? To a large extent it consisted in what the clergy of a certain church would call "irregularity"—some want of conformity with ecclesiastical rules and requirements. It was by no means always coincident with immorality. A man might have a lively sense of "sin" in connection with some purely ceremonial matter, and very little sense of wrong-doing in connection with the most grievous offenses against his fellow-man. In obedience to the "code of honor," men who regarded themselves as pillars of church and state would prepare to commit deliberate murder; while they would always consider a gambling debt as vastly more sacred than one incurred for food or clothing. The "Christian" nations have found enormous quantities of "sin" in heresy, and very little indeed in mutual bloodshed on the most appalling scale. Pious monarchs have appeased their consciences by persecuting the Jews, and pious folk generally by hunting witches. According to popular opinion in our own day, the Divine anger is much more quickly kindled by the parody of a religious rite than by the most hideous villainy perpetrated by a man upon his neighbor. Every now and again there is a story in the papers about some boy or man struck blind or dumb for blasphemy, or of the personal appearance of the devil among some group of revelers engaged in profanely mocking a religious ceremony! So various have been the aspects in which "sin" has presented itself, and so little relation has it seemed to bear in any of its best recognized forms with practical morality, that it is not to be wondered at if scientific men show some impatience with so vague and unsatisfactory a conception, and prefer to consider all conduct simply in its bearing on intelligible human interests. As to disease, they necessarily regard it as the great enemy, primarily, of man's physical estate, and secondarily of his intellectual and moral constitution; and if their chief efforts are bent on its extermination, it would be hard to say in what more useful work they could be engaged.

The next fault that Miss Cobbe finds with the scientific spirit, which she characterizes as "analytic, self-asserting, critical," is

that it is directly opposed to the "synthetic, reverential, sympathizing spirit of art"; and she holds up to scorn the physicist who can not enjoy the representation of figures suspended in the air in defiance of the law of gravity, and the zoölogist who fails to admire cherubs without stomachs, and centaurs with a stomach to spare. Well, if we must confess it, our sympathy in each case is with the man of science; and we refuse to believe, on any evidence as yet tendered, that art would be less art if it condescended to recognize the laws of the physical universe. The poet Horace was no mean artist in his day, nor is there any reason to suppose that he was a victim to the scientific spirit; yet he has left on record his distaste for all such composite and unnatural creations as Miss Cobbe takes under her protection. He thought the centaur and the mermaid both very ridiculous figures. "Let a thing be what it may," he said, "but let it be simple, let it preserve its unity." * The greatest sculptors the world ever saw, those of ancient Greece, devoted themselves almost wholly to the delineation of the human form in its ideal perfection; their art may have sought to transcend the actual, but not the possible. If they strove to better nature, it was not by flying in the face of natural laws, but by a happier blending of natural elements; just as the gardener of to-day shows us what may be realized by giving to various plants better conditions than can be commanded in the rude competition for existence. Miss Cobbe will have it that the scientific spirit would kill poetry. We do not believe a word of it; but we do believe that the scientific spirit applied to poetry would purge it of many morbid growths and ridiculous conceits. Some not incompetent judges are of the opinion that the very poem cited by Miss Cobbe in illustration, Shelley's "Sensitive-Plant," is overladen with imagery. The late Mr. Arnold did not find Shelley quite "sane" enough to be a poet of the first order; and if representatives of the scientific spirit occasionally find something in his verse that they can not quite reconcile with common sense, they may plead that they are only finding what a great literary critic had already found. In lieu of such delicate fancies as Shelley has woven into his "Sensitive-Plant," the scientific spirit, we are told, would "describe how the garden had been thoroughly drained and scientifically manured with guano and sewage." This is not argument; it is hysteria running a little toward coarseness.

But may it be claimed that science is advancing the interests of truth? No; not the science of our time. We are simply gathering facts and deducing laws, subject to rectification when further facts shall have been gathered. But "in other days truth was deemed something nobler than this. It was the interests

* "Denique sit quidvis, simplex duntaxat et unum."—*Ars Poetica*, 23.

that lay behind and beyond the facts, their possible bearings on man's deepest yearnings and sublimest hopes, which gave dignity and meaning to the humblest researches into rocks and plants." A little definition would come in well here. What *are* the interests that lie beyond the facts? What *are* man's deepest yearnings? What *are* his sublimest hopes? Are his sublimest hopes also his best-founded and most rational hopes? Are his deepest yearnings at all of a practical character? If these yearnings can be appeased at all by scientific conclusions, why not by those arrived at in our day as well as by the less correct ones arrived at in former days? Finally, what can science do more than put the most rational construction on facts? If more than this is wanted—some surplusage of belief—it can be got from other quarters; science should not be held responsible for furnishing it, or blamable for not furnishing it. Miss Cobbe does not seem to be of this opinion, however. She says that, as "Science has repeatedly renounced all pretension to throw light in any direction beyond the sequence of physical causes and effects, she has . . . abandoned her claim to be man's guide to truth." But surely, if at any time in the past Science made good her claim to transcend the sequence of physical causes and effects, we need not concern ourselves with her present denegation of authority in the higher region. If a teacher has really succeeded in teaching us the calculus, we need not trouble ourselves much if he should at some future time take it into his head that he never knew it himself. Supposing even that he never did know it, and that we only worked into it by the aid of his blunders, does not our knowledge remain? And what, in that case, can we do better than turn round and teach our teacher? On the other hand, if our teacher never knew what he thought he knew, and if we never learned what we thought we had learned, what can we both do better than acknowledge the true state of the case, and begin over again, should it seem desirable?

We are told that Darwin "has destroyed, for those who accept his views, the possibility for a rational reverence for the dictates of conscience." How? By raising a doubt as to "whether the convictions of man's mind, which has been developed from the mind of the lower animals, *are of any value*." We should suppose that, the further back an organism could be traced, the more authority might be attached to what seem to be its laws. Who would not much rather trust a conscience that had a long history behind it, one stretching back even into the brute creation, than a brand-new article of whose genesis no satisfactory account could be given? Moreover, how is it that we think so little of another man's conscience when it enjoins acts of which we disapprove; and that he thinks so little of ours when it enjoins acts of which

he disapproves? It no more occurs to us to think that the Deity has specially enlightened him on the point in question, than it occurs to him to pay our conscientious conviction a similar compliment. We get over the difficulty, not improbably, by hinting that he is a "crank," and the same mode of escape is open to him in relation to us. The criticism of conscience, as Miss Cobbe must well know, antedates Darwin by at least three centuries. The philosopher whose motto was "*Que sais-je?*" expounded its weaknesses more fully than Darwin ever did; and Locke defines it very briefly as "our own opinion of the moral rectitude or pravity of our own actions." Dugald Stewart shows that the sentiment of the sacredness of property varies from country to country, according to the amount of labor requisite to produce articles of value; and that in other respects local accidents decide to a great extent the form that moral opinion takes. Hartley explained the phenomena of conscience by association; and, since his day, to go no further back, the idea of conscience as a special organ uttering the voice of the Deity has been weakening among thinking men. The evolutionists of to-day have simply succeeded in giving a wider basis to views that were in the world long before their time; but to say that they have in any way lowered the dignity of man's moral nature is to state what is not the case. Miss Cobbe is pleased to suggest that the old ideas gave a basis for moral effort "as firm as the law of the universe itself"; but that henceforth our only fulcrum will be "the sand-heap of hereditary experiences." If anything could less deserve the designation of "sand-heap" than our accumulated hereditary experiences, we should like to know what it is. In the case of the sand-heap there is an utter lack of cohesion; in the case of hereditary experiences cohesion is of their very nature. Miss Cobbe understands this perfectly; it is a pity she should have written as though she did not.

We are very far, therefore, from admitting that "the scientific spirit" has "sprung a mine under the deepest foundations of morality"; or that it is as impossible for a man who holds the evolutionary idea of the origin of conscience "to cherish a great moral ambition as it is for a stream to rise above its source." If, on the one hand, science moderates ambition by keeping before the mind the limits of the possible, on the other it stimulates ambition by producing the conviction that certain things are not only possible, but certain of attainment if the right means are used. There was a time in the history of science when men were laboring to transmute the baser metals into gold; that particular ambition has been abandoned with others equally chimerical; but it surely can not be said that science to-day discourages effort in the field of chemistry? Precisely so in the moral region: we no

longer expect to work miracles, but we do expect and hope by wisely concerted measures to accomplish better and greater results than were ever accomplished by the enthusiasms and fanaticisms of the past. Miss Cobbe says that "the man of science may be anxious to abolish vice and crime, . . . but he has no longing to enthrone in their place a lofty virtue demanding his heart and life's devotion. He is almost as much disturbed by extreme goodness as by wickedness." Is not this weak and almost meaningless language? What is meant by "enthroning a lofty virtue" in the place of vice and crime? The phrase has a fine sound, but it seems to be a case of *præterea nihil*. What a man of science would like to see would be a society organized and governed according to the best knowledge of the time. He would like to see the laws of life and health respected, justice maintained among men, and free scope given to individual development. As to the lofty virtue which Miss Cobbe so strongly desiderates, the scientific man would like to do away with the necessity for it by a general leveling up of human life. He believes, with Jean Jacques Rousseau, that prudence is a virtue which enables us to dispense with many others; and that, if the human race could be taught prudence, great reformers and missionaries might have an easy time of it, and perhaps be enabled to practice a little of their charity at home—an excellent starting-point, according to the proverb. The scientific man's ideal is necessarily a prosperous community of fairly self-sufficing individuals, not a world of misery lightened by the angel visitations and exertions of a few heroic souls. Some may think his ambition a low one, but he does not feel it to be so himself; he does not really see how any one who wishes well to the mass of his fellow-men can have any different ambition.

"Another threatening evil from the side of science is the growth of a hard and pitiless temper." So Miss Cobbe; and this in face of the fact that never in the history of the world was there so much sympathy with suffering, or so ready a recognition of the rights of humanity, as there is to-day. Reference is made to certain vague charges brought in an anonymous book against hospital physicians and students; but, even admitting these charges as true in some substantial measure—and we should be sorry to do so without further proof—no good reason can be assigned for charging on the scientific world at large a morbid temper displayed by a few representatives of one single profession. Compare the average practicing physician of to-day with the Slops and Sangrados of former times, and we fancy there is no visible falling off in humanity or any other respectable quality. What can not be denied is that science has done a great work in mitigating suffering and lengthening human life; and it would

be strange indeed if the ministers of these benefits were themselves indifferent to the very objects of their labors.

Finally, joining hands with M. de Laveleye, Miss Cobbe declares that science destroys religion. The only reply to give on this point is just this: that, if science and religion are natural enemies, one must destroy the other; that if they are not, if each has its basis in nature, then neither will destroy the other; but, after a mutual adjustment of their claims, each will confirm and strengthen the other. Science is nothing else than knowledge of the facts and laws of the universe. If religion can not survive the acquisition of such knowledge by mankind, then it must perish; but we should be sorry to affirm that its position is so precarious. One thing is certain, Science can not go back. She has begun a series of interpretations of the great book of Nature that prove to be of ever-increasing interest from year to year. She can not stop in this career. The book has only been fairly opened; the true key to its hieroglyphs has just been found; the practical results already achieved by means of the knowledge acquired are full of advantage in the present and of promise for the future; what is there to do, therefore, but to go forward? Men of science may, as individuals, fall into many errors. They may fail to realize the true dignity of their calling; they may be unduly swayed by party spirit or by personal aims; they may be unworthy ministers of the truths which they deliver. But science, what is it but truth? And what is the scientific spirit but the spirit that bows to truth? To all who are dissatisfied with the present currents of thought we would, therefore, say: "Criticise men as much as you please. Point out their errors, their failings, intellectual and moral, with all needful severity. Hold up the standard by which you think their lives and thoughts ought to be governed. Criticise theories, too. Let nothing pass unchallenged or unscrutinized that you are not satisfied is true. Let no glamour of great names, no popularity of certain modes of thought, deter you from expressing your dissent from what you do not believe. But do not put yourselves hopelessly in the wrong by attacking science, or by abusing the scientific spirit. You will gain nothing by it, but will merely darken your understandings, and shut yourselves out from the light that is ready to lighten every man that comes into the world. Science will abide. It has its roots in the everlasting rocks, and draws its aliment from universal nature. The scientific spirit will abide, admonishing men of their errors, and leading them into all truth. It is wise to be reconciled to such powers as these; even now, while you are in the way with them, make terms of peace, and find rest to your souls."

THE SUANETIANS AND THEIR HOME.*

By DOUGLAS W. FRESHFIELD.

A NEW recreation-ground is wanted for those of our countrymen who, without being travelers by profession, find pleasure and refreshment in rough travel among primitive people, in mountain scenery and glacier air, in that sense of adventure and discovery which is afforded only by unknown countries or virgin heights, and on unmapped snowy chains. To such travelers—or vacation tourists—I offer the Caucasus. Here, if they make a hobby of map construction and correction, or of any branch of natural science, or of linguistic and ethnological studies, they will find a field for much useful work. At any rate, they may enjoy themselves, and while they do so they can hardly fail to increase knowledge. The country has been brought well within the reach of vacation tourists, of every one with a two months' holiday.

Nineteen years ago I described the first journey of exploration made by mountaineers, in the technical sense of that word, in the Caucasus, the ascents of its two most famous peaks, Elbruz and Kazbeck, and the general character of the snowy-chain that connects them. In July, 1887, in the company of M. de Déchy, and with Alpine guides, I revisited this noble chain, twice crossed some of its greatest glaciers, climbed several of its peaks, and penetrated many hitherto unknown recesses. In the course of these wanderings the mazes of the central group were unraveled, and several orographical problems which had puzzled intermediate travelers received their final solution.

For the moment I propose to limit myself to some notes on the scenery and people of a single district of the Caucasus, the mountain-girt basin of Suanetia, and one or two sketches of travel among its glaciers and snow-fields. Suanetia is the upper basin of the Ingur, a river which flows into the Black Sea a few miles east of Sukkum Kaleh. It is about the size of the valley of Aosta, forty miles long by fifteen broad. It lies between three thousand and seven thousand feet above the sea. On its north run the snowy ramparts of the Caucasian crest, inclosing in their complicated ridges four great glacier basins, and sending down more directly toward the Ingur or its tributaries many ice-streams, such as the Adish, which would be ranked in the Alps as glaciers of the first class. These ridges are composed of crystalline rocks, which show the tendency, observable in the Alps (e. g., in the Mont Blanc and Pelvoux groups), to arrange their

* From a paper read before the Royal Geographical Society, March 12, 1888.

summits in double lines, in the troughs between which lie vast *névés*. On either flank of the rigid granites lie beds of friable schists, whose green, rounded outlines afford a striking contrast to the snowy precipices of the great chain on which they abut. On the south Suanetia is fenced in by the lofty slate ridge of the Leila, which, running parallel to the main chain, attains a height of over twelve thousand feet, and bears very considerable glaciers toward its western end. In this direction the river escapes, between high spurs of the two chains, through a narrow porphyritic gorge, which is not at present passable for horses. On the east a low, grassy down (eight thousand six hundred feet), only sixteen hundred feet above the highest villages, leads into a pathless maze of forests and flowers—the wilderness in which the Skenes Skali, a tributary of the Rion, has its sources. Within these ridges and gorges the inhabitants have lived for centuries, isolated from the outer world, forgetting and forgotten.

They are first mentioned by Strabo, under the name of Soani, as a powerful nation; but Suaneti, as far as I could learn, is what they now call themselves. At the last census they numbered about twelve thousand. Over one third of the race, known from the native prince who ruled over them as the Dadian's Suanetians, live on the upper Skenes Skali. They have been more or less merged in the surrounding Mingrelian populations. The Suanetians are mentioned by Pliny and Procopius. Their country was reserved by Chosroes for Persia in his treaty with Justinian. It was converted to Christianity before the tenth century, and covered with small chapels or churches. Seven hundred years ago it formed part of the kingdom of Queen Thamara, the heroine who occupies the place of Alexander or Charlemagne in Georgian legend. The Suanetians still chant ballads in her honor. Suanetia soon fell off from the Georgian kingdom. It became, at some time in the last century, wholly unattached. Since that time the district has enjoyed a complete form of communal rule. Each community is made up of several villages, originally consisting each of members of the same family or *gens*, but now including several families. Members of the same family can not intermarry. Women and pasturage rights have been occasions of many feuds and vendettas. When a woman changed hands or husbands, the parties concerned could not always agree on the value in cattle—the Suanetians had no money—of the lady exchanged. Hence arose assaults of persons and batteries of towers. The affairs of the hamlet, so far as they were not settled by appeals to arms, were regulated by an assembly of adult males, in which unanimity was required for a valid decision. The foreign relations of the Suanetians consisted, for the most part, in predatory excursions into their neighbors' pastures. They were

arrant sheep-stealers and cattle-lifters. Strangers met with no hospitality. On the contrary, it was the custom to exact a payment from them for passage, and the custom still survives in petty demands made for halting in a remote village. The Suanetians may fairly be described as reverted pagans. Some Christian rites—fasting in Lent, and the use of the sign of the cross—they have doubtless preserved. But these survivals seem to me no more to entitle them to the name of Christians than our own midsummer-night fires constitute us sun-worshipers. The country is covered with small churches and chapels, dating probably from the eleventh and twelfth centuries, built, unlike the houses and towers, of regularly squared blocks of limestone; the apse is sometimes ornamented externally with carving or an arcade of columns in low relief. The bells, as in Corsica, are suspended from a wooden frame outside the church. The altar-screens are arranged as in Greek churches. Long before Suanetia had obtained home-rule, it had advanced to church disestablishment. The priests disappeared, and their place was taken by a hereditary caste of local elders, who superintended the village feasts and sacrifices. The ecclesiastical property was secularized; a village vestry assumed its control, and kept the key of the church, which, no longer reserved for pious uses, served principally as a treasure-house. Inside, in heavy chests, were stored the sacred books and images—some of them beautiful works of art—Persian silks, strange three-sided pieces of wood, carved with old Georgian inscriptions, flint-headed spears and arrows, and dozens of horns of the Caucasian *tur*. These things are still kept locked up, and it is almost impossible for any stranger to see them. The priests having been disposed of, services and sacraments naturally went too. Marriage consisted in sewing together the garments of the bride and bridegroom; baptism was travestied; the ancient funeral ceremonies were revived or continued. Many graves surround the churches, but others are found under particular trees. It is obvious that tree-worship survives in Suanetia. In the center of many hamlets there is a venerable tree or trunk—walnut, birch, or cherry—under which stand two or three rude chairs. Doubtless these are old places of assembly. The people are said (on the authority of a Mingrelian priest) to venerate the heavenly bodies. The Suanetians who carried our goods over the chain, appeared to pray to and praise the sun directly. They do no work on Friday, Saturday, or Sunday, thus partially making up for their shortcomings by keeping the Sabbaths of three religions.

The Suanetians had home-rule and church disestablishment and disendowment. They had solved another pressing problem: they had, without emigration, overcome the natural tendency of

the population to increase beyond the limits that their territory would support. They had even caused it to diminish. Their system was simple and effectual. They put a pinch of ashes, at birth, into the mouths of all superfluous female babies. They took a masculine view of superfluity. At the last census there were four males to three females in the Ingur Valley.

Poetry, where it exists—above all, primitive poetry and local ballads—often gives a nearer insight into the condition of life and manners of a race than religious rites and beliefs. Dr. Radde has fortunately preserved a number of very curious Suanetian ballads, such as are still sung under some ancient tree, or on the march along the mountain-path. They celebrate the golden time of Thamara, past forays across the great chain into the lands of the Baksan Tartars, or among the Abkasians to the west.

Under Russian rule a change is slowly coming over the people; schools, perhaps the only effectual civilizers, are doing their work. Everywhere I noticed in the rising generation an absence of the wild-animal expression which was the characteristic of the free Suanetians twenty years ago, and which all travelers have observed.

The Suanetians are not mainly a pastoral people. They keep a few flocks of sheep and herds of horses. Bullocks are used to draw sledges, and are eaten in winter. But flocks and herds are seldom found, as among the Tartars beyond the chain, on the high pastures, and consequently there are no paths to them. To reach the upper glacier basins you must find and follow almost untraceable hunters' tracks. Pigs, the smallest breed I ever saw, and geese wander round the homesteads, which are guarded by dogs. The villages are surrounded by barley-fields fenced in with neat wattling. The paths between them are pleasant, and less stony than most Alpine mule-roads. The inhabitants have learned to cultivate potatoes and other vegetables. They cut a certain amount of hay on the high pastures. Sometimes they cross the chain in summer, and let themselves out as laborers to the indolent Tartars; but there is no love lost between them. The Mussulmans look on the Suanetians with contempt as pig-eaters. I heard the Suanetians hiss "Cherkess!" at our Kabardan Cossack; and the Cossack—a mild and amiable creature, the reverse of the popular idea of a Cossack—despised and distrusted every Suanetian from the bottom of his soul. A race-hatred of centuries was recognizable in its ashes.

Variety is the marked type characteristic of the Suanetians. One village head-man, huge and bull-like, was like a figure from an Assyrian monument. Of the three men who led our baggage-horses from Ushkul, one wore the clothes and had something of the air and manners of a Persian gentleman. Another was a

splendid, good-tempered, fair giant. Fair men with tawny heads are common. The third was a tattered, dark, stumpy, noisy barbarian. The costumes and manners of the women are various.

After its natural beauties, its peaks and forests, what strikes the traveler in Suanetia is the local architecture. The castellated villages which lawlessness has produced are as prominent in his eyes as the castles of the robber barons are to the Rhine tourist, or the towers of San Gemignano to those who wander in Italian by-ways. Nothing more strangely fantastic can be imagined than these towered hamlets. Mestia alone has seventy towers, from forty to eighty feet high, Ushkul about fifty, and two castles besides. Let me try to describe, from a sketch, a street scene in Chubiani, one of the hamlets of Ushkul, seven thousand feet above the sea. The house is a square block, built of irregular pieces of slate and slate-roofed. The only windows are small holes, high up, and unclosed. The smoke escapes through the roof. Birch-bark torches are used at night. A wooden passage, capable of being cut down in case of emergency, leads to the tower of refuge. Let us enter the house: it consists of one large ill-lighted room; two or three rude stones form the hearth; there are a few rough wooden benches and stools on the earthen floor; in the corner is a raised wooden platform with skins and cushions, the family couch. Groping up a dark passage, we reach the tower. Ladders, easily removable, reach from story to story. The ladders are short, and to gain each story one is compelled to scramble up projecting stones left in the wall. Skulls of wild goats, and other odds and ends, lie about on the landings. On the top story are loop-holes for firing. These towers, unlike the churches, are built of untrimmed black slates, generally whitewashed. At Ushkul, however, there are two castles, one fifty the other five hundred feet above the village (attributed, of course, to Queen Thamara), in which the black slate has been left in its native color. In the lower castle I found a ruined chapel. The higher castle commands a view of the pass to the Upper Skenes Skali, and must have been the defense of this entrance to the valley. M. Bussanio Nichoradse, a native of Ushkul, and a schoolmaster, told me that in ancient times all the families in a village were bound to assist their neighbor who was building a tower, but that no new towers had been raised, though many had been repaired, within his memory. A somewhat similar custom existed in the present generation at Chamounix.

"Savage Suanetia," the title chosen by an enthusiastic sportsman for the most recent description of this district, although in one sense appropriate, seems to me, so far as nature is concerned, singularly unhappy. Smiling, sylvan—such are the epithets that come naturally to the traveler's lips as he suddenly

emerges from the icy regions of the Caucasus into the wooded hills, gentle slopes, sunny meadows, and neatly fenced barley-fields. Compared with the warrens or stone-heaps which serve the Tartars of the northern valleys for dwellings, even the towered villages have at a distance a false air of civilization. Suanetia in June, in the flower-time of the rhododendrons and azaleas, and again in October, when the azalea-leaves are red, and the birches golden against fresh autumn snows, must be one of the wonders of the world. Spaciousness, sunniness, variety, are the constant qualities of Suanetian landscapes. The great basin of the Ingur, forty miles long by ten to fifteen broad, is broken by no ridges that approach the snow-line, and the long, undulating, grassy spurs that divide the glens, in place of narrowing the horizon, furnish in their soft lines the most effective contrast possible to the icy peaks and rigid precipices of Shkara and Tetnuld, of Ushbe and the Leila. From the varied beauty of forests and flowers the eyes are carried at once to the pure glaciers, which hang like silver stairs on the green lower slopes of the snowy chain. The atmosphere has none of the harshness of that of Switzerland in summer. The breezes from the Black Sea bring up showers and moisture to soften the outlines and color the distances; the wind from the steppe suffuses the air with an impalpable haze, through which the great peaks glimmer like golden pillars of the dawn.

THE HISTORY OF A DOCTRINE.*

By Prof. S. P. LANGLEY.

II.

THE first five years of this century are notable in the history of radiant energy, not only for the work of Leslie, and for the observation by Wollaston, Ritter, and others, of the so-called "chemical" rays beyond the violet, but for the appearance of Young's papers, re-establishing the undulatory theory, which he indeed considered in regard to light, but which was obviously destined to affect most powerfully the theory of radiant energy in general.

We are now in the year 1804, or over a century and a quarter since the corpuscular theory was emitted, and during that time it has gradually grown to be an article of faith in a sort of scientific church, where Newton has come to be looked on as an infallible head, and his views as dogmas, about which no doubt is to be tolerated; but if we could go back to Cambridge in the year 1668,

* President's address before the American Association for the Advancement of Science, at Cleveland, Ohio, August 15, 1888. Reprinted from "Science."

when the obscure young student, in no way conscious of his future pontificate, takes his degree (standing twenty-third on the list of graduates), we should probably find that he had already elaborated certain novel ideas about the undulatory theory of light, which he at any rate promulgates a few years later, and afterward, pressed with many difficulties, altered, as we now know, to an emissive one.

Probably, if we could have heard his own statement then, he would have told how sorely tried he was between these two opinions, and, while explaining to us how the wavering balance came to lean as it did, would have admitted, with the modesty proper to such a man, that there was a great deal to be said on either side. We may, at any rate, be sure that it would not be from the lips of Newton himself that we should have had this announced as a belief which was to be part of the rule of faith to any man of science.

But observe how, if Science and Theology look askance at each other, it is still true that some scientific men and some theologians have, at any rate, more in common than either is ready to admit; for at the beginning of this century Newton's followers, far less tolerant than their master, have made out of this modest man a scientific pontiff, and out of his diffident opinions a positive dogma, till, as years go on, he comes to be cited as so infallible that a questioning of these opinions is an offense deserving excommunication.

This has grown to be the state of things in 1804, when Young, a man possessing something of Newton's own greatness, ventures to put forward some considerations to show that the undulatory theory may be the true one, after all. But the prevalent and orthodox scientific faith was still that of the material nature of light; the undulatory hypothesis was a heresy, and Young a heretic. If his great researches had been reviewed by a physicist or a brother worker, who had himself trodden the difficult path of discovery, he might have been treated at least intelligently; but, then, as always, the camp-followers, who had never been at the front, shouted from a safe position in the rear to the man in the dust of the fight, that he was not proceeding according to the approved rules of tactics; then, as always, these men stood between the public and the investigator, and distributed praise or blame.

If you wish to hear how the scientific heretic should be rebuked for his folly, listen to one who never made an observation, but, having a smattering of everything books could teach about every branch of knowledge, was judged by himself and by the public to be the fittest interpreter to it, of the physical science of his day. I mean Henry Brougham, the future Lord-Chancellor of England, the universal critic, of whom it was observed that, "if he had but known a little law, he would have known a little of everything."

He uses the then all-powerful "Edinburgh Review" for his pulpit, and notices Young's great memoir as follows: "This paper contains nothing which deserves the name either of experiment or discovery; and it is, in fact, destitute of every species of merit. . . . The paper which stands first is another lecture, containing more fancies, more blunders, more unfounded hypotheses, more gratuitous fictions, . . . and all from the fertile yet fruitless brain of the eternal Dr. Young. In our second number we exposed the absurdity of this writer's 'law of interference,' as it pleases him to call one of the most incomprehensible suppositions that we remember to have met with in the history of human hypotheses."

There are whole pages of it, but this is enough; and I cite this passage among many such at command, not only as an example of the way the undulatory theory was treated at the beginning of this century in the first critical journal of Europe, but as another example of the general fact that the same thing may appear intrinsically absurd, or intrinsically reasonable, according to the year of grace in which we hear of it. The great majority, even of students of science, must take their opinions ready-made as to science in general; each knowing, so far as he can be said to know anything at first hand, only that little corner which research has made specially his own. The moral we can all draw, I think, for ourselves.

In spite of such criticism as this, the undulatory hypothesis of light made rapid way, and carried with it, one would now say, the necessary inference that radiant heat was due to undulations also. This was, however, no legitimate inference to those to whom radiant heat was still a fluid; and yet, in spite of all, the modern doctrine now begins to make visible progress.

A marked step is taken about 1811 by a young Frenchman, De la Roche, who deserves to be better remembered than he is, for he clearly anticipated some of Melloni's discoveries. De la Roche in particular shows that of two successive screens the second absorbs heat in a less ratio than the first; whence he, before any one else, I believe, derives the just and most important, as well as the then most novel conception, that radiant heat is of different kinds. He sees also that, as a body is heated more and more, there is a gradual and continual advance not only in the amount of heat it sends out, but in the kind, so that, as the temperature still rises, the radiant heat becomes light by imperceptible gradations; and he concludes that heat and light are due to one simple agent, which, as the temperature rises yet more, appears more and more as light, or which, as the luminous radiation is absorbed, reappears as heat. Very little of it, he observes, passes even transparent screens at low temperatures, but more and more does so as the temperature rises. All this is a truism in 1888, but it is admirably

new as well as true in 1811; and if De la Roche had not been removed by an early death, his would have not improbably been the greatest name of the century in the history of our subject; an honor, however, which was in fact reserved for another.

The idea of the identity of light and radiant heat had by this time made such progress that the attempt to polarize the latter was made in 1818 by Berard. We have just seen in Herschel's case how the most sound experiment may lead to a wrong conclusion, if it controverts the popular view. We now have the converse of this in the fact that the zeal of those who are really in the right way may lead to unsound and inconclusive experiment; for Berard experimentally established, as it was supposed, the fact that obscure radiant heat can be polarized. So it can, but not with such means as Berard possessed, and it was not till a dozen years more that Forbes actually proved it. At this time, however fairly we seem embarked on the paths of study which are followed to-day, and while the movement of the main body of workers is in the right direction, it is yet instructive to observe how eminent men are still spending great and conscientious labor, their object in which is to advance the cause, while the effect of it is to undo the little which has been rightly done, and to mislead those who have begun to go right.

As an instance both of this and of the superiority of modern apparatus, we may remark—after having noticed that the ability of obscure heat to pass through glass, if completely established, would be a strong argument in favor of its kinship to light, and that De la Roche and others had indicated that it would do so (in which we now know they were right)—that at this stage, or about 1816, Sir David Brewster, the eminent physicist, made a series of experiments which showed that it would not so pass. Ten years later, in view of the importance of the theoretical conclusion, Baden Powell repeated his observations with great care, and confirmed them, announcing that the earlier experimenters were wrong, and that Brewster was right. Here all these years of conscientious work resulted in establishing, so far as it could be established, a wholly wrong conclusion in place of a right one already gained. It may be added that, with our present apparatus, the passage of obscure radiant heat through glass could be made convincingly evident in an experiment which need not last a single second.

We are now arrived at a time when the modern era begins; and in looking back over one hundred and fifty years, from the point of view of the experimenter himself, with his own statement of the truth as he saw it, we find that the comparison of the progress of science to that of an army, which moves, perhaps with the loss of occasional men, but on the whole victoriously and in one

direction, is singularly misleading; and I state this more confidently here, because there are many in this audience who did not get their knowledge of nature from books only, but who have searched for the truth themselves; and, speaking to them, may I not say that those who have so searched know that the most honest purpose and the most patient striving have not been guarantees against mistakes—mistakes which were probably hailed at the time as successes? It was some one of the fraternity of seekers, I am sure, who said, "Show me the investigator who has never made a mistake, and I will show you one who has never made a discovery."

We have seen the whole scientific body, as regards this particular science of radiant energy, moving in a mass, in a wrong direction, for a century; we have seen that individuals in it go on their independent paths of error; and we can only wonder that an era should have come in which such a real advance is made as in ours.

That era has been brought in by the works of many, but more than by any other through the fact that in the year 1801 there came into the world at Parma an infant who was born a physicist, as another is born a poet; nay, more; who was born, one might say, a devotee of one department of physics—that of radiant heat; being affected in his tenderest years with such a kind of precocious passion for the subject as the childish Mozart showed for music. He was ready to sacrifice everything for it; he struggled through untold difficulties, not for the sake of glory or worldly profit, but for radiant heat's sake; and when fame finally came to him, and he had the right to speak of himself, he wrote a preface to his collected researches, which is as remarkable as anything in his works. In this preface he has given us, not a summary of previous memoirs on the subject, not a table of useful factors and formulæ, not anything at all that an English or American scientific treatise usually begins with, but the ingenuous story of his first love, of his boyish passion for this beloved mistress; and all this with a trust in us his readers which is beautiful in its childlike confidence in our sympathy. I must abbreviate and injure in order to quote; but did ever a learned physical treatise and collection of useful tables begin like this before?—

"I was born at Parma, and when I got a holiday used to go into the country the night before and go to bed early, so as to get up before the dawn. Then I used to steal silently out of the house, and run, with bounding heart, till I got to the top of a little hill, where I used to set myself so as to look toward the east." There, he tells us, he used, in the stillness of nature, to wait the rising sun, and feel his attention rapt, less with the glorious spectacle of the morning light itself than with the sense of the mysterious

heat which accompanied its beams, and brought something more necessary to our life and that of all nature than the light itself.

The idea that not only mankind, but nature, would perish though the light continued, if this was divorced from heat, made a profound impression, he tells us, on his childish mind. The statement that such an idea could enter with dominating force into the mind of a child will perhaps seem improbable to most. It will, however, be comprehensible enough to some here, I have no doubt.

Is there some ornithologist present who remembers a quite infantile attraction which birds possessed for him above all the rest of the animated creation; some chemist whose earliest recollections are of the strange and quite abnormal interest he found as a child in making experimental mixtures of every kind of accessible household fluid and solid; some astronomer who remembers when a very little creature that not only the sight of the stars, but of any work on astronomy, even if utterly beyond his childish comprehension, had an incomprehensible attraction for him? I will not add to the list. There are, at any rate, many here who will understand and believe Melloni when he tells how this radiant heat, commonplace to others, was wonderful to his childish thought, and wrought a charm on it such that he could not see wood burn in a fireplace, or look at a hot stove, without its drawing his mind, not to the fire or iron itself, but to the mysterious effluence which it sent.

This was the youth of genius; but let not any fancy that genius in research is to be argued from such premonitions alone, unless it can add to them that other qualification of genius which has caused it to be named the faculty of taking infinite pains. Melloni's subsequent labors justified this last definition also; but I can not speak of them here, further than to say that, after going over a large part of his work myself, with modern methods and with better apparatus, he seems to me the man, of all great students of our subject, who, in reference to what he accomplished, made the fewest mistakes.

Melloni is very great as an experimenter, and owes much of his success to the use of the newly invented thermopile, which is partly his own. I can here, however, speak only of his results, and of but two of these—one generally known; the other, and the more important, singularly little known, at least in connection with him. The first is the full recognition of the fact, partly anticipated by De la Roche, that radiant heat is of different kinds, that the invisible emanations differ among themselves just as those of light do. Melloni not only established the fact, but invented a felicitous term for it, which did a great deal to stamp it on recognition—the term "thermochrose," or heat-color, which

helps us to remember that, as the visible and apparently simple emanation of light is found to have its colors, so radiant heat, the invisible but apparently simple emanation, has what would be colors to an eye that could see them. This result is well known in connection with Melloni.

The other and the greater, which is not generally known as Melloni's, is the generalization that heat and light are effects of one and the same thing, and merely different manifestations of it. I translate this important statement as closely as possible from his own words. They are that "*Light is merely a series of calorific indications sensible to the organs of sight, or Vice Versa, the radiations of obscure heat are veritable* INVISIBLE RADIATIONS *of light.*" The italics and the capitals are Melloni's own. He wishes to have no ambiguity about his announcement behind which he may take shelter; and he had so firm a grasp of the great principle that, when his first attempts to observe the heat of the moon failed, he persevered, because this principle assured him that where there was light there must be heat. This statement was made in 1843, and ought, I think, to insure to Melloni the honor of being the first to distinctly announce this great principle. The announcement passed apparently unnoticed, in spite of his acknowledged authority; and the general belief not merely in different entities in the spectrum, but in a material caloric, continued as strong as ever. If you want to see what a hold on life error has, and how hard it dies, turn to the article "Heat," in the eighth edition of the "Encyclopædia Britannica," where you will find the old doctrine of caloric still in possession of the field in 1853; and still later, in the generally excellent "English Encyclopædia" (edition of 1867), the doctrine of caloric is, on the whole, preferred to the undulatory hypothesis. It is very probable that a searcher might find many traces of it yet lingering among us; so that Giant Caloric is not, perhaps, even yet quite dead, though certainly grown so crazy, and stiff in the joints, that he can now harm pilgrims no more.

So far as I know, no physicist of eminence reasserted Melloni's principle till J. W. Draper, in 1872. Only sixteen years ago, or in 1872, it was almost universally believed that there were three different entities in the spectrum, represented by actinic, luminous, and thermal rays. Draper remarks that a ray consists solely of ethereal vibrations whose lost *vis viva* may produce either heat or chemical change. He uses Descartes's analogy of the vibration of the air, and sound; but he makes no mention either of Descartes or of Melloni, and speaks of the principle as leading to a modification of views then "universally" held. Since that time the theory has made such rapid progress that, though some of the older men in England and on the European continent have not

welcomed it, its adoption among all physicists of note may be said to be now universal, and a new era in our history begins with it. I mean by the recognition that there is one radiant energy which appears to us as "actinic," or "luminous," or "thermal" radiation, according to the way we observe it. Heat and light, then, are not things in themselves, but, whether different sensations in our own bodies or different effects in other bodies, are merely effects of this mysterious thing we call radiant energy, without doing more in this than give a name to the ignorance which still hangs over the ultimate cause.

I am coming down dangerously near our own time—dangerously for one who would be impartial in dealing with names of those living and with controversies still burning. In such a brief review of this century's study of radiant energy in other forms than light, it has been necessary to pass without mention the labors of such men as Pouillot and Becquerel in France, of Tyndall in England, and of Henry in America. It has been necessary to omit all mention of those who have advanced the knowledge of radiant energy as light, or I should have had to speak of labors so diverse as those of Fraunhofer, of Kirchhoff, of Fresnel, of Stokes, of Lockyer, and many more. I have made no mention, in the instructive history of error, of many celebrated experimental researches; in particular of such a problem as the measurement of solar heat, great in importance, but apparently most simple in solution, yet which has now been carried on from generation to generation, each experimenter materially altering the result of his predecessor, and where our successors will probably correct our own results in time. I have not spoken of certain purely experimental investigations, like those of Dulong and Petit, which have involved immense and conscientious labor, and have apparently rightly earned the name of "classic" from one generation, only to be recognized by the next as leading to wholly untrustworthy results, and leaving the work to be done again with new methods, guided by new principles.

In these instances, painstaking experiments have proved insufficient, less from want of skill in the investigator than from his ignorance of principles not established in time to enable him to interpret his experiments; but, if there were opportunity, it would be profitable to show how inexplicably sometimes error flourishes, grows, and maintains an apparently healthy appearance of truth, without having any root whatever. Perhaps I may cite one instance of this last from my own experience. About fifteen years ago it was generally believed that the earth's atmosphere acted exactly the part of the glass in a hot-bed, and that it kept the planet warm by exerting a specially powerful absorption on the infra-red rays.

I had been trained in the orthodox scientific church, of which I am happy to be still a member; but I had acquired perhaps an almost undue respect, not only for her dogmas, but for her least sayings. Accordingly, when my own experiments did not agree with the received statement, I concluded that my experiments must be wrong, and made them all over again, till spring, summer, autumn, and winter had passed, each season giving its own testimony; and this for successive years. The final conclusion was irresistible, that the universal statement of this alleged well-known fact (inexplicable as this might seem, in so simple a matter) was directly contradicted by experiment.

I had some natural curiosity to find how every one knew this to be a fact; but search only showed the same statement (that the earth's atmosphere absorbed dark heat like glass) repeated everywhere, with absolutely nowhere any observation or evidence whatever to prove it, but each writer quoting from an earlier one, till I was almost ready to believe it a dogma superior to reason, and resting on the well-known "*Quod semper, quod ubique, quod ab omnibus, creditum est.*"

Finally, I appear to have found its source in the writings of Fourier, who, alluding to De Saussure's experiments (which showed that dark heat passed with comparative difficulty through glass), observes that, if the earth's atmosphere were solid, it would act as the glass does. Fourier simply takes this (in which he is wholly wrong) for granted; but as he is an authority on the theory of heat, his words are repeated without criticism, first by Poisson, then by others, and then in the text-books; and, the statement gaining weight by age, it comes to be believed absolutely, on no evidence whatever, for the next sixty years, that our atmosphere is a powerful absorber of precisely those rays which it most freely transmits.

The question of fact here, though important, is, I think, quite secondary to the query it raises as to the possible unsuspected influence of mere tradition in science, when we do not recognize it as such. Now, the Roman Church is doubtless quite logical in believing in traditions, if these are recommended to the faithful by an infallible guide; but are we, who have no infallible guide, quite safe in believing all we do, with our fond persuasion that in the scientific body mere tradition has no weight?

In even this brief sketch of the growth of the doctrine of radiant energy, we have perhaps seen that the history of the progress of this department of science is little else than a chapter in that larger history of human error which is still to be written, and which, it is safe to say, would include illustrations from other branches of science as well as my own.

But—and here I ask pardon if I speak of myself—I have been

led to review the labors of other searchers from this standpoint, because I had first learned, out of personal experience, that the most painstaking care was no guarantee of final accuracy; that to labor in the search for a truth with such endless pains as a man might bestow if his own salvation were in question did not necessarily bring the truth; and because, seeking to see whether this were the lot of other and greater men, I have found that it was, and that, though no one was altogether forsaken of the Truth he sought (or, on the whole review of his life as a seeker, but might believe he had advanced her cause), yet there was no criterion by which it could be told at the time whether, when after long waiting there came in view what seemed once more her beautiful face, it might not prove, after all, the mockery of error; and probably the appeal might be made to the experience of many investigators here with the question, "Is it not so?"

What then? Shall we admit that truth is only to be surely found under the guidance of an infallible church? If there be such a church, yes! Let us, however, remember that the church of science is not such a one, and be ready to face all the consequences of the knowledge that her truths are put forward by her as provisional only, and that her most faithful children are welcome to disprove them. What then, again? Shall we say that the knowledge of truth is not advancing? It is advancing, and never so fast as to-day; but the steps of its advance are set on past errors, and the new truths become such stepping-stones in turn.

To say that what are truths to one generation are errors to the next, or that truth and error are but different aspects of the same thing to our poor human nature, may be to utter truisms; but truisms which one has verified for one's self out of a personal experience are apt to have a special value to the owner; and these lead, at any rate, to the natural question, "Where is then the evidence that we are advancing in reality, and not in our own imagination?"

There are many here who will no doubt heartily subscribe to the belief that there is no absolute criterion of truth for the individual, and admit that there is no positive guarantee that we, with this whole generation of scientific men, may not, like our predecessors, at times go the wrong way in a body, yet who believe as certainly that science as a whole, and this branch of it in particular, is advancing with hitherto unknown rapidity. In asking to be included in this number, let me add that to me the criterion of this advance is not in any ratiocination, not in any *a priori* truth, still less in the dictum of any authority, but in the undoubted observation that our doctrine of radiant energy is reaching out over nature in every direction, and proving itself by the

fact that through its aid nature obeys us more and more; proving itself by such material evidence as is found in the practical applications of the doctrine, in the triumphs of modern photography, in the electric lights in our streets, and in a thousand ways which I will not pause to enumerate.

And here I might end, hoping that there may be some lessons for us in the history of what has been said. I will venture to ask the attention to one more, perhaps a minor one, but of a practical character. It is that in these days, when the advantage of organization is so fully realized, when there is a well-founded hope that by co-operation among scientific men knowledge may be more rapidly increased, and when in the great scientific departments of government and elsewhere there is a tendency to the formation of the divisions of a sort of scientific army—a tendency which may be most beneficially guided—that at such a time we should yet remember that, however rapidly science changes, human nature remains much the same; and (while we are uttering truisms) let us venture to say that there is a very great deal of this human nature even in the scientific man, whose best type is one nearly as unchanging as this nature itself, and one which can not always advantageously be remodeled into a piece of even the most refined bureaucratic mechanism, but will work effectively only in certain ways, and not always at the word of command, nor always best in regiments, nor always best under the best of discipline.

Finally, if I were asked what I thought were the next great steps to be taken in the study of radiant heat, I should feel unwilling to attempt to look more than a very little way in advance. Immediately before us, however, there is one great problem waiting solution. I mean the relation between temperature and radiation; for we know almost nothing of this, where knowledge would give new insight into almost every operation of nature, nearly every one of which is accompanied by the radiation or reception of heat, and would enable us to answer inquiries now put to physicists in vain by every department of science, from that of the naturalist as to the enigma of the brief radiation of the glow-worm, to that of the geologist who asks as to the number of million years required for the cooling of a world.

When, however, we begin to go beyond the points which seem, like this, to invite our very next steps in advance, we can not venture to prophesy; for we can hardly discriminate among the unlimited possibilities which seem to open before a branch of knowledge which deals especially with that radiant energy which sustains, with our own being, that of all animated nature, of which humanity is but a part. If there be any students of Nature here, who, feeling drawn to labor in this great field of hers, still doubt whether there is yet room, surely it may be said to them,

"Yes, just as much room as ever, as much room as the whole earth offered to the first man"; for that field is simply unbounded, and everything that has been done in the past is, I believe, as nothing to what remains before us.

The days of hardest trial and incessant bewildering error in which your elders have wrought seem over. You "in happier ages born," you of the younger and the coming race, who have a mind to enter in and possess it, may, as the last word here, be bidden to indulge in an equally unbounded hope.

[*Concluded.*]

GAUSS AND THE ELECTRIC TELEGRAPH.

WE have been favored with the following interesting letter, giving some facts in relation to Prof. Gauss in addition to the sketch of this distinguished mathematician which appeared in "The Popular Science Monthly" for September, 1888, and inclosing the appended extracts from letters by Gauss in regard to his invention of a form of electric telegraph:

DENVER, COLORADO, *October 24, 1888.*

DR. W. J. YOUMANS, *New York.*

DEAR SIR: Please allow me, as a grandson of Carl Friedrich Gauss, the German mathematician, to thank you for the sketch of his life and works which appeared in the September number of "The Popular Science Monthly." I should have made this acknowledgment long ago, and intended doing so, but for various reasons postponed it from time to time, for which I beg your pardon.

There are two slight errors in your article, one, at least, of which is hardly worth mentioning. The first is in regard to the date of Prof. Gauss's birth. "The Popular Science Monthly" article says that he was born on April 23, 1777. In fact, however, he was born on April 30th of that year.

The other error amounts to little, but perhaps you may think it worth correcting. You say that he and Prof. Weber sent telegraphic signals from Göttingen to a neighboring town. They were, in fact, sent only from the astronomical observatory to the physical cabinet, which was under the direction of Prof. Weber; this was in 1833. The wire used was about eight thousand feet long; it was destroyed by a stroke of lightning in 1845. On pages 64 and 65 of "Gauss zum Gedächtniss," by W. Sartorius von Waltershausen, there is a description of this telegraphic line. In a work entitled, I believe, "Electricity in the Service of Man," there is a picture of the telegraphic apparatus used by Gauss and Weber.

Inclosed herewith I send you a translation of parts of two letters written by Gauss in regard to the telegraph; they will explain themselves. I also send a copy of the original, for possibly the translation is not wholly correct. The last letter written by Prof. Gauss was to Sir David Brewster, in relation to the early discovery of the electric telegraph. I have tried to obtain either the original or a copy of this letter, but thus far I have not succeeded. I regret this all the more, for the reason that I believe it would be of interest to the public if it were published.

It may be of interest to you to know that one of Prof. Gauss's children is still living. He is my father, and he resides in the country a short distance from the town of Columbia, Mo. He is now in his seventy-eighth year. His name is Eugene. Another son, William, came to America about 1836, and died in St. Louis, Mo., in 1879. Gauss's youngest child, a daughter named Theresa, resided with her father in Göttingen at the time of his death. She herself died about twenty years ago in Europe. These were children by his second marriage. Also, by his first marriage, Gauss had two sons and one daughter. The oldest, Joseph, became "Oberbaurath" of Hanover. He died in the city of Hanover in 1873. The daughter, Minna, became the wife of Prof. Ewald, the author of a "History of the People of Israel" and a number of commentaries on different books of the Old Testament. As a Hebraist he ranked as high as, I believe, if not higher than, Gauss as a mathematician. The youngest of the children by the first marriage, Louis, died in infancy. Ewald's wife died in 1840. None of Gauss's descendants have exhibited remarkable talent in any way.

I trust I have not wearied you with these family matters.

Very truly, etc., R. GAUSS.

P. S.—By the way, Prof. Weber is still living, and to-day is his birthday. He is eighty-four years old.

At a meeting of the Electro-Technic Association held in Berlin in 1883, Prof. W. Forster, director of the Berlin Observatory, read the following extracts from letters written by Prof. C. F. Gauss, of Göttingen, in relation to the early invention of the electric telegraph:

"I don't remember," writes Gauss to Olbers, on the 20th of November of the year 1833, "my having made any previous mention to you of an astonishing piece of mechanism that we have devised. It consists of a galvanic circuit conducted through wires stretched through the air over the houses up to the steeple of St. John and down again, and connecting the observatory with the physical laboratory, which is under the direction of Weber. The entire length of wire may be computed at about eight thou-

sand feet. Both ends of the wire are connected with a multiplicator, the one at my end consisting of one hundred and seventy, that in Weber's laboratory of fifty coils of wire, each wound around a one-pound magnet suspended according to a method which I have devised. By a simple contrivance—which I have named a commutator—I can reverse the current instantaneously. Carefully operating my voltaic pile, I can cause so violent a motion of the needle in the laboratory to take place that it strikes a bell, the sound of which is audible in the adjoining room. This serves merely as an amusement. Our aim is to display the movements with the utmost accuracy. We have already made use of this apparatus for telegraphic experiments, which have resulted successfully in the transmission of entire words and small phrases. This method of telegraphing has the advantage of being quite independent of either daytime or weather; the one who gives the signal and the one who receives it remain in their rooms, with, if they desire it, the shutters drawn. The employment of sufficiently stout wires, I feel convinced, would enable us to telegraph with but a single tap from Göttingen to Hanover, or from Hanover to Bremen."

The following remarks occur in a letter written by Gauss to H. C. Shumacher, dated August 6, 1835: "In more propitious circumstances than mine, important applications of this method could, no doubt, be made, enuring to the advantage of society and exciting the wonder of the multitude. With an annual budget of one hundred and fifty thalers for observatory and magnetic laboratory together (I make this statement to you in strictest confidence) no grand experiments can be made. Could thousands of dollars be expended upon it, I believe electro-magnetic telegraphy could be brought to a state of perfection, and made to assume such proportions as almost to startle the imagination. The Emperor of Russia could transmit his orders without intermediate stations, in a minute, from Petersburg to Odessa, even peradventure to Kiakhta, if a copper wire of sufficient strength were conducted safely across and attached at both ends to powerful batteries, and with well-trained managers at both stations. I deem it not impossible to design an apparatus that would render a dispatch almost as mechanically as a chime of bells plays a tune that has been arranged for it. One hundred millions' worth of copper wire would amply suffice for a continuous chain to reach the antipodes; for half the distance, a quarter as much, and so on, in proportion to the square of the distance."

At the same meeting the following dispatch was sent to Prof. William Weber, at Göttingen: "The Electro-Technic Association celebrates to-day the year 1883, as the fiftieth anniversary of the first successful operation of the electric telegraph, and salutes you

as the still surviving associate in that great achievement. At the same time it expresses renewed homage for Gauss, who at that period, in conjunction with you at Göttingen, achieved so great a result, and at the same time clearly recognized the future of this creation."

THE SACRIFICE OF EDUCATION.

A PROTEST.

AS an indication of the present state of feeling in England toward the system of public education in that country, and especially toward the abuse of examinations, we reprint the following vigorous protest, which is signed by over a hundred professors and teachers, about seventy members of Parliament, and by members of the nobility, clergymen, and others, to the total number of four hundred. We omit the names for lack of space. The sentiments expressed in the protest are enforced in appended communications from Prof. Max Müller, Mr. E. A. Freeman, and Mr. Frederic Harrison, which it is our purpose to print next month:

We, the undersigned, wish to record our strong protest against the dangerous mental pressure and misdirection of energies and aims which are to be found in nearly all parts of our educational system. Alike in public elementary schools, in schools of all grades and for all classes, and at the universities, the same dangers are too often showing themselves under different forms. Children—as is so frequently insisted on—are treated by a public department, by managers and schoolmasters, as suitable instruments for earning Government money; young boys of the middle and richer classes are often trained for scholarships, with as little regard for the future as two-year-old horses are trained for races; and young men of real capability at the universities are led to believe that the main purpose of education is to enable them to win some great money prize, or take some distinguished place in an examination.

We protest emphatically against such a misdirection of education, and against the evils that necessarily arise from it.

We wish at the outset to call the attention of parents and teachers to the resulting physical mischief. One of the first duties of a child or young person is to grow well. In the rapid formation of new bone, muscle, and tissue of all kinds, Nature lays on a child a very heavy tax—a tax that should absorb the larger part of its surplus energy. It is probable that in the course of every year some valuable young lives are lost, in cases where this energy has been drawn away by mental overstrain

from the work which it has primarily to perform, and where there is in consequence a failure of strength to meet the *sequelæ* of scarlet fever or other serious illness. Even in the great number of cases where no strongly marked ill-effect discloses itself during the years of youth, there are sufficient grounds for believing that what is unsparingly taken at this period of life is taken at the expense of future vigor and capability. It has, moreover, to be borne in mind that mental overpressure and brain irritation, on the one side, are likely, just as idleness and want of occupation the other, to increase among boys peculiar physical (and moral) dangers of a most serious character—dangers which are but little regarded by the public, but which always exist where boys are massed together.

We consider that, together with a general failure to keep steadily in view the true ends of education, great examinations and the valuable prizes attached to them are responsible for a large part of this overstrain placed on young bodies and young minds. Let these great prizes once exist in the education market, and we must expect that boys and young men will train for them, regardless of higher and more important considerations; that parents and teachers will allow themselves to join in the emulation —a few, perhaps, of their number mentally protesting, while looking on with "somber acquiescence."

By the side of the physical evils, at which we have glanced, stand equally serious evils of an intellectual and moral kind:

1. It should be noted that under the prize-system all education tends to be of the same type, since boys from all schools of the same grade meet in the same competition, and all teaching tends to be directed toward the winning of the same prizes. No more unfortunate tendency could be imagined. The health and progress of every great science, such as education, depend upon continual difference, upon new ideas, and experiments carried out to give effect to such ideas; upon the never-ending struggle between many different forms and methods, each to excel the other. It can not be too often repeated that uniformity means arrest of growth and consequent decay; diversity means life, growth, and adaptation without limit.

2. We hold that the preponderating influence of examinations destroys the best teaching. Under it the teacher loses his own intelligent self-direction. He can not devote his powers to such parts of a subject as are most real to himself, and most deeply felt by himself (though on this depend the impressiveness of all teaching and the awakening of permanent interest in those taught), as he is constantly controlled by the sense of the coming examination, in which of course he wishes his pupils to succeed. The pupil, on the other hand, allows himself to be mechanically guided

for the sake of success. His mental sympathies become bounded by the narrowest horizon. "What will pay" in the examination becomes his ruling thought, and he turns away from the many new intellectual interests, which would spring up on all sides of one who was allowed to be in love with knowledge for its own sake, as from luxuries that must be sternly put aside for the sake of success in the all-important examination. To a young and healthy mind the constant suggestiveness that accompanies work done in every branch of knowledge, the constant opening up of new interests, are the great stimulants to self-development, and they should be ever spurring the student on to endeavor to know more and to see more clearly. We hold that these life-giving interests can not possibly coexist with the repressing influences of training for great examinations.

3. The true value of different kinds of education can not be so intelligently considered and so easily measured by the public when these great prizes are in existence. It is most undesirable that important controversies, whether between classical and scientific education, or between the various methods of teaching, should be obscured by the serious monetary considerations that now throw their shadow over all educational work.

We do not propose to discuss here other more subtle evils, which appear to many of us to result from doing work simply for the sake of an all-important examination, such as the temporary strengthening of the rote-faculties to the neglect of the rational faculties, the rapid forgetfulness of knowledge acquired, the cultivation of a quick superficiality and power of cleverly skimming a subject, the consequent incapacity for undertaking original work, the desire to appear to know rather than to know, the forming of judgment on great matters where judgment should come later, the conventional treatment of a subject and loss of spontaneity, the dependence upon highly skilled guidance, the belief in artifices and formulated answers, the beating out of small quantities of gold-leaf to cover great expanses, the diffusion of energies over many subjects for the sake of marks, and the mental disinclination that supervenes to undertake work which is not of a directly remunerative character, after the excitement and strain of the race; nor will we discuss another class of evils, that falls less directly on the student, such as the waste of very precious time inflicted on the teacher by the drudge-work of examinations. It is enough now to affirm that the moral effect of the system, viewed broadly, is distinctly bad. We have made of our education a body without a soul. Our misdirected efforts result in a system which is *corruptio optimi*. There is no nobler influence that can be brought to bear upon a young student than the desire to get knowledge for the sake of understanding the world in which he

has to live, the marvelous forces among which he has to act, the humanity of which he forms part, and thus of preparing a life of mental activity and happiness for himself, and of enlightened usefulness to others; but this influence is almost entirely set aside by the prize system. Only too often the greater part of the knowledge acquired for an examination, and the life which the student has presently to lead, are to him as matters separated by a great gulf, almost without connection with each other. We can not help asking why we should thus throw away the noblest and most enduring inducements that we possess, and put in their place motives which, except for the desperate effort of the moment, must be poor and unfruitful. We can find no good grounds for believing that the simple love of knowledge for its own sake, which at different periods of the world has acted so powerfully upon young and ardent minds, has in itself lost any of the old sacred fire; nor can we for a moment admit that the boys and young men of higher aspirations, who would be ready to follow Knowledge in a high and worthy spirit, should be sacrificed by an ignobly conceived system to the inferior-minded—if there are such—who can only be tempted to follow her because she means a sum of money, the public triumph of a successful class, or the gaining of a place. For those who can only be induced to work for such motives, let their friends provide in some special fashion such rewards and stimulants as they may find necessary; but for the higher type of boys and young men (and we believe they will gradually prove to be far the larger number, when we have once shaken ourselves free from the corrupting influences of the present system) let the effort be to offer the only true kind of teaching—the teaching of those who are in love with their subjects, and would, if allowed, devote themselves to calling out the same feeling in their pupils. At the present moment both teacher and pupil are morally depressed and incapacitated by a system that deliberately sets itself to appeal to the lower side of human nature. Again and again brilliant young men, once full of early promise, go down from the universities as the great prize-winners, and do little or nothing in the after-years. They have lived their mental life before they are five-and-twenty. The victory of life has seemed to them gained, and knowledge exhausted, almost before the threshold of either has been crossed.

It can not be too often insisted on that examination is a good educational servant, but a bad master. It is a useful instrument in the hand of a teacher to test his own work, and to know how far his pupils have followed and profited by his teaching. But it necessarily exerts a fatal influence whenever it is made of such importance that teachers simply conform to an external standard, lose faith in themselves, sink into the position of their own text-

books, and give but little of their own personality to their work. It is true that it is necessary to test the work of teachers; but it is not necessary, for the purpose of doing so, to take the whole soul out of teaching. If examinations are to be defended on the ground that they test the efficiency of teachers, then we reply that other and better ways of doing this are to be found, and must be found. We admit quite frankly that they can only be found and pursued at the price of some trouble and experiment on the part both of parents and those responsible for the conduct of teaching; but if trouble and thought and experiment are to be spared in this great matter, we had better at once resign the hope of attaining any moral and intellectual results of real value from what we are doing. It has been suggested that masters and tutors might be induced to publish regularly notes of some of their courses; it has been suggested that some of the periodical examinations of boys and young men by their own masters and professors should be printed—with the questions and answers made—and sold in some cheap form; that parents and others interested should be invited to attend *viva voce* examinations. It is urged that such publicity would help to enlighten those specially interested as to the teaching given at different schools and colleges; and act as a moderate and healthy stimulus both to teachers and taught, without in any way producing the evil effects of the present fiercely competitive prize-system. We can not here attempt to express any opinion upon such proposals; but every reasonable plan for giving parents some acquaintance with what their sons are learning, and the methods pursued, deserve careful consideration.

In conclusion, we protest against the waste that accompanies the mischievous exaggeration of our present systems of examination. We protest against the great endowments of schools and universities being applied as money rewards for learning, either in the form of scholarships or fellowships, when they might be applied to increasing teaching-power, attracting men of high and varied learning as teachers to the universities, endowing concurrent chairs so as to admit the expression of different schools of thought on the same subjects, lowering to a certain point the fees taken for attendance, carrying the teaching of the universities into many different parts of the country, and assisting education in many other direct and useful ways. We protest against the common mistake of benefactors—anxious to help education—founding new scholarships, and thus intensifying the evil that exists, instead of founding local chairs and local courses of teaching; we renew our protest against the low ideals placed before young men; against the highly artificial competition to which both parents and teachers give their adhesion, and which destroys the real natural competition of method competing against method and type against

type; and we protest against the assigning of Government positions by competition—a system which sets an evil example throughout the country and which does not insure the choice of the most fit. That the Government should require a high class of knowledge and attainment from those seeking for its appointments is reasonable; but the difficulties which attend the selection of candidates should not be allowed to bring upon us in wholesale fashion (though indirectly) the great evils which result from competitive examinations. It is urged—and the whole matter deserves serious consideration—that it would be better that some system should be sought out under which, for example, those who wished to enter the civil service, and who reached a certain standard of excellence required by the commissioners, should be practically tested in such way and for such period as could be conveniently arranged; that the most fitting should then be selected on public grounds by the permanent heads of departments. It is urged that some such a course—and others are to be suggested—should be preferred to the excessive and hurtful stimulus of special training for the one purpose of defeating in a great educational contest other candidates, also specially trained for the same purpose, and to the consequent encouragement of competitive examination throughout the whole country by the force of Government example. Here also we desire to express no opinion of any kind upon the suggestion given, but simply to point out how important it is that those who are most qualified should turn their attention to this subject with the view of discovering the best way of avoiding both the evils that belonged to the past and those that belong to the present.

We have only to add that what we have said as regards the education of young men and boys necessarily applies with increased force to young women and girls. It is deeply to be regretted that their education is becoming simply a stale repetition of the mistakes made in the case of men. In their instance it is to be expected that the injuries to health and bodily vigor will be even greater; while the delicate perceptive powers, which they possess in larger measure than men, are likely to suffer irreparable injury. We can only hope that with the abolition of the class and prize system there will grow up a much more delicate appreciation than exists at present of the subtle influences, both for good and for evil, of education; and that the easy credulity with which this generation has placed "book learning" before a careful training of the senses and higher faculties may slowly give way to truer views.

We ought to add that we sign this paper in general agreement with the principles expressed in it, and not as individually expressing entire adhesion to all details.—*Nineteenth Century.*

SKETCH OF MOSES ASHLEY CURTIS.

THE Rev. MOSES ASHLEY CURTIS, D. D., presents the example of a clergyman who, doing hard pioneer missionary work in the mountains of North Carolina, and caring actively and efficiently for the wants of his parish, brought the botany of his State to a full development. Making that study his pastime and recreation, "he found pleasure in the quiet of the fields and forests, and, without ever a thought of becoming a scientific botanist, amassed a wealth of knowledge and won an exalted position among the botanists of the world." His services to science have, nevertheless, been unaccountably overlooked. Although he was in constant co-operation with the most distinguished specialist in the world on fungi, although he contributed more than any other man to the knowledge of the botany of North Carolina, and particularly of its mountain-region, and was continually consulted and relied upon for information by Dr. Gray and other American botanists, his name does not appear in any cyclopædia or publicly circulated work. Our data for the present account of his career are derived from a sketch of his botanical work prepared by Dr. Thomas F. Wood, of Wilmington, N. C., and read by him before the Elisha Mitchell Scientific Society of the University of North Carolina, in 1885.

Dr. Curtis was born in Stockbridge, Mass., May 11, 1808, and died in Hillsborough, N. C., in 1872. He was graduated from Williams College in 1827, and in 1830 became a tutor in the family of Governor Dudley, at Wilmington, N. C. He returned to Massachusetts in 1833, and spent two years in studying for the ministry, under the Rev. William Croswell. He returned to the South in the latter part of 1834, was married in December of that year, and, having continued his theological studies under the Rev. Dr. R. B. Drane, was ordained a clergyman in the Protestant Episcopal Church in 1835. He immediately entered upon mission-work in western North Carolina, from Charlotte to the mountain country as far north as Morganton. Leaving this work at the end of 1836, he was engaged as a teacher in the Episcopal school at Raleigh during 1837 and 1838 and till May, 1839. During 1840 he performed missionary work about Washington, in Beaufort County; then, in 1841, became settled in Hillsborough for six years; removed, in 1847, to Society Hill, S. C., where he resided for nine years; and returned, in 1856, to Hillsborough, which was his home for the remainder of his life.

The first mention of Mr. Curtis's field studies in botany is associated with his residence and tutorship in Wilmington, where he devoted his leisure hours to the examination of the flora of the

region. Especially on Saturdays he made excursions among the sand-hills and savannas near the village (it was then), close up to whose borders the pine-forests reached, "abounding with a flora rich and novel to the enthusiastic young botanist." In a little more than two seasons he made collections of 1,031 species, equivalent to about one fourth of the phenogamous flora of the United States as then known; most of the plants having been found within about two miles' radius of Wilmington, with a number of maritime species discovered at Smithville and several from Rocky Point. The results of these studies were given to the public as an "Enumeration of Plants growing spontaneously around Wilmington, North Carolina, with Remarks on some New Obscure Species," which appeared in the "Boston Journal of Natural History," September, 3, 1834. Most of the first edition of the publication was burned; but it was reprinted, with additions and emendations. Dr. Gray mentions this work as one of the first in America in which the names are accented; and Dr. Darlington commended Mr. Curtis, even at this beginning of his scientific career, as a careful observer and sagacious botanist. At this time the literature of American botany consisted chiefly of florulas or local floras, of which the best known were those of New York, by Dr. Samuel L. Mitchel and Major John le Conte; Boston, by Dr. Jacob Bigelow; Washington, by Dr. J. A. Brereton; and Lexington, Ky., by Prof. C. W. Short. In North Carolina, Prof. Elisha Mitchell and the Rev. Dr. L. De Schweinitz had been studying the plants; Mr. H. B. Croom and Dr. H. Loomis printed a catalogue of plants found growing in the neighborhood of Newbern, at nearly the same time that Mr. Curtis's work saw the light; Dr. James F. McCree, Sr., was cultivating botany at Wilmington, and, the two having learned to co-operate with each other, added several species to the catalogue, thirty-four in notes and a number in the catalogue proper; Dr. Cyrus L. Hunter had prepared a list of plants found in Lincoln County; while the Rev. Dr. Bachman, Mr. H. W. Ravenel, and Mr. Leitner were looking after the plants near their homes in South Carolina and Georgia.

"If there is such a thing as a scientific instinct," says Dr. Wood, "Mr. Curtis possessed it. He was habitually accurate in his studies, and the results were early relied upon by his correspondents. Coming into a new field of botanical study, it was quite natural that he should have directed his attention to the very local *Dionœa muscipula*. Saturday after Saturday he would visit the savannas, and, lying at length upon the ground, would watch its peculiarities. The popular description which he gave of it in the 'Enumeration of Plants around Wilmington' has been repeated for the last fifty years, and shows how greatly he possessed the gift of accurate and entertaining description." Dr.

Gray says that in this note he "corrected the account of its wonderful action that had prevailed since the time of Linnæus, and confirmed the statement and inferences of the first scientific describer, Ellis—namely, that this plant not only captures insects, but consumes them, enveloping them in a mucilaginous fluid which appears to act as a solvent." The journeys which he had to make in pursuing his mission-work in the mountainous region were turned to the advantage of his botanical studies. He kept a portfolio under the cushion of his sulky, ready to receive any specimen which he might find; so that, when he reached the end of his journey, he had collected a considerable number of specimens to study during his leisure hours, or to mount permanently in his herbarium. Dr. Gray acknowledged himself greatly indebted to him for local information concerning the flora of this region, and said, in a paper in which he sketched the tours of the botanists who had visited the mountains of North Carolina in 1841, that no living botanist was so well acquainted with the vegetation of the Southern Alleghany Mountains, or had explored that of the State so extensively, as he. A half-century after the publication of the Wilmington catalogue, only about fifty species had been added to Mr. Curtis's list. One of these was the true maiden-hair fern (*Adiantum capillus-Veneris*), which was found by Mr. William M. Canby, of Wilmington, Del., in 1867, at Hilton Ferry. Specimens were immediately sent to Mr. Curtis, and he improved the first opportunity to visit the locality and see the plant *in situ* for himself.

Dr. Curtis's labors on the fungi began at least as early as 1846, when he became engaged in a correspondence with Mr. H. W. Ravenel, of South Carolina, a large collector in this department. About two years after this he entered into correspondence with the Rev. M. J. Berkeley, of England, concerning which we learn that that very distinguished authority on this subject became greatly attached to him "by reason of the ardor and accuracy with which he pursued the investigation of new species. . . . Correspondence between these gentlemen continued for a number of years, and a scientific copartnership was formed which resulted in the addition of nearly five hundred new species (besides more than twelve hundred identified by De Schweinitz, chiefly in North Carolina) to the list up to 1867; and since Dr. Curtis's death a number of new species appeared in 'Grevillea,' under the joint authorship of Berkeley and Curtis." This new field of study was greatly to Dr. Curtis's liking, and he became very skillful in the microscopic work necessary to the determination of species. He became too devoted to it, perhaps, for his health was undermined in consequence of the close attention he gave to it. It was a genuine case of pure love of the work; for the stimuli and temp-

tations to labor for distinction which exist now were wanting in his day; and thus he was led, almost unconsciously, to a very high station among American botanists. Concerning this, he remarked to Dr. Wood: "Nothing surprised me more than to be called a botanist at first. Although I had accomplished the survey of the phenogamous plants of the State, I still felt that I was comparatively not a botanist." Several years later than this—about 1855—he began to give special attention to the edible mushrooms. He finally became a kind of missionary and propagandist of mushroom-eating. In the catalogue of the plants of North Carolina he had indicated one hundred and eleven species of edible fungi known to inhabit the State; and he had no doubt that there were forty or fifty more, in the less explored Alpine regions. He was accustomed to distribute basketfuls of the choicest specimens among his friends, "until the divine art of mycophagy reached a good degree of cultivation, and many of them learned to distinguish for themselves the edible ones. Some members of his family became especially expert in foraging for the table among the mushrooms"; and his son used the knowledge thus acquired in preparing the colored illustrations for the contemplated work on "Edible Fungi." This book was projected during the civil war, when the food-question was a vital one in Southern households, and was intended to make popular the use of mushrooms. In it, Dr. Wood affirms, the author succeeded in divesting himself of every technicality, and indeed in describing minutely about forty of the one hundred and eleven species in language easy to be understood, and in an enticing manner. Illustrations and comparisons were occasionally drawn from foreign authors. The work failed to find a publisher.

Dr. Curtis's studies of plants embraced every feature and relation that he was able to bring under observation. "Just to name a flower and preserve it carefully in his herbarium," says Dr. Wood, "was to him but the beginning of his work. His earliest records show that he studied the relation of plant-life to geologic and climatic surroundings. The study of botanical geography was begun and continued during his whole career as a botanist, extending over thirty-eight years. The account he has given us in his 'Woody Plants' is to-day the best guide to the natural climatological divisions of the State which has ever been given. His studies were also directed to the numerous economic questions which met him in his intimate acquaintance with the treasures of the field and forest. It was this feature of his labors alone which brought him an audience in his adopted State, and with this object in view he brought together the material which he published as a part of the Geological and Natural History Survey, known best by the condensed title given to it by Prof. Em-

mons as the 'Woody Plants.' This volume, of one hundred and twenty-four pages, was printed by the State in 1860, and at once became a popular manual for the farmer and the woodsman, and for amateur botanists a key to the more conspicuous trees and shrubs useful for their fruit or timber or as ornaments. The key devised to enable one of no botanical knowledge to determine a given plant or shrub was founded upon the character of the fruit and distinguished by the common name. The preface of this little work is an introduction to the geographical distribution of plants in the State, and shows what a thorough acquaintance he had with the vast subject." The essay made prominent the exceptional position which North Carolina holds in respect to climate, soil, and forest products, by calling attention to the existence of a difference in elevation between the eastern and western parts, which gives a difference of climate equivalent to ten or twelve degrees of latitude. The work displays an accurate knowledge of common names, with all the local changes which they undergo. It has been liberally drawn from by subsequent writers, not always with due acknowledgment. In "A Commentary on the Natural History of Dr. Hawks's 'History of North Carolina,'" published in the "University Magazine" in 1860, Dr. Curtis corrected many errors into which the author had fallen by accepting the exaggerated and too highly colored accounts of the old travelers and explorers concerning the plant-growth of the State.

Dr. Curtis's "Catalogue of the Indigenous and Naturalized Plants" of North Carolina was published by the State in 1867 as a part of the Geological and Natural History Survey. At the time of its issue the author asserted that, comprising forty-eight hundred species, it was the most extensive local list of plants ever published in North America. It is claimed to have been the first attempt to enumerate the cryptogamous as well as the phenogamous plants ever made by any botanist in this country. It consisted of one hundred and fifty-eight pages of catalogue, with no scientific description, but a mere statement of the locality of each plant, and was the result of twenty-five years of botanical study over a territory of fifty thousand square miles. Pathological mycology had only begun to be studied in Dr. Curtis's lifetime. An incident related by Dr. Wood suggests that, had he engaged in this branch of investigation, he might have become a master of the subject. A group of doctors were examining some figures of microscopic fungi in Beale's "Microscope in Practical Medicine," and particularly the *Oïdium albicans*, which was supposed to be a cause of thrush. Dr. Curtis coming in, at once recognized a very familiar fungus, and, showing that the spores could only find lodgment when the soil was prepared to receive them, cau-

tioned his friends against forming too hasty conclusions as to the disease-carrying properties of the fungi. Instead of being the cause of disease, they were as likely to be its result.

Dr. Curtis had an extensive correspondence with American and European botanists, who always recognized the part he took in the progress of the science in this country as important. Dr. Chapman dedicated the first edition of his "Flora of the Southern States" to him. The "American Journal of Science" in 1873, after his death, thus measured his work: "All our associate's work was marked by ability and conscientiousness. With a just appreciation both of the needs of science and of what he could best do under the circumstances, when he had exhausted the fields in phenogamous botany within his reach, he entered upon the inexhaustible ground of mycology, which had been neglected in this country since the time of Schweinitz. In this difficult department he investigated and published a large number of new species, as well as determined the old ones, and amassed an ample collection, the preservation of which is most important, comprising, as it does, the specimens, drawings, and original notes which are to authenticate his work. By his unremitting and well-directed labors, filling the intervals of honored and faithful professional life, he has richly earned the gratitude of the present and ensuing generations of botanists."

The bibliography of Dr. Curtis's writings includes "Enumeration of Plants growing spontaneously around Wilmington, N. C." (1834), twice reprinted with additions and emendations; "New and Rare Plants of North Carolina" (1842); "Contributions to Mycology of North America" (1848); "New and Rare Plants, chiefly of the Carolinas" (1849); "Contributions to Mycology of North America" (Berkeley and Curtis, 1849); "New Fungi collected by the Wilkes Exploring Expedition" (1851); "Geological and Natural History Survey of North Carolina; Part III, Botany, containing a Catalogue of the Plants of the State, with Description and History of the Trees, Shrubs, and Woody Vines" (1860); "A Commentary on the Natural History of Dr. Hawks's 'History of North Carolina'" (1860); "Esculent Fungi" (1866); "Geological and Natural History of North Carolina; Part III, Indigenous and Naturalized Plants" (1867); "Edible Fungi of North Carolina" (1839). The first of these works was published in the Boston "Journal of Natural History," and the last in the "Gardener's Chronicle," London. The others were published either in "Silliman's Journal" or as separate publications.

CORRESPONDENCE.

A CORRECTION.

Editor Popular Science Monthly:

MR. McGEE, in his article on "Paleolithic Man in America," in the November issue, falls into an unfortunate error in stating that I had found twenty-five thousand specimens of true paleolithic implements *in the gravel*. The number found is about four hundred, and this represents twelve years of most laborious search for them. Happily, it is enough to establish the fact that paleolithic man existed at the time so graphically described in McGee's article.

The error is explained, I am sure, by the author having in mind the number of catalogued specimens of the Abbott collection at the Peabody Museum at Cambridge, Mass. This collection is not of glacial man only, but of his immediate successor—the Eskimo?—and of the Delaware Indians.

CHARLES C. ABBOTT.

TRENTON, N. J., *November* 27, 1888.

RELATION OF ALTRUISM TO EGOISM.

Editor Popular Science Monthly:

SIR: Having read, with interest, Mr. Smiley's article on "Altruism" in your November number, I venture to point out what seem, in my view, to be his errors and mistaken reasonings:

At the outset, while ignoring the fact that an intelligent and reasonable self-sacrifice lies at the very basis of the Christian system, he virtually confounds it with the extreme self-abnegation of Buddhism. There is a fundamental difference between the two. The latter system involves the utter renunciation of individuality by an absorption in Nirvana. This is the total annihilation of personal identity, the abnegation of all selfhood. For this end Buddhism demands painful and extreme penance and the denial to all good. It aims primarily, for others, at the removal of this life's lower evils, its physical woes and material necessities, and for its devotee it works mainly, if not chiefly, toward his own personal deliverance from such ills, toward a virtual non-existence.

The Christian system is just the reverse of this. Pre-eminently it recognizes and maintains the individuality of every man, disintegrating him from the great mass of humanity, and making him, separately and personally, accountable to a great Creator and a Supreme Judge. While aiming, subordinately, at the counteraction of this life's lesser evils, it strikes at the greater and gigantic forms of moral ill, lifting humanity up to a higher spiritual plane of blessedness. Thus, by means of self-discipline and wise sacrifice, it promotes human good, recognizing all men as of one great brotherhood.

Mr. Smiley then takes isolated passages of the Bible, out of their proper connection, unmodified and unbalanced by others, thus giving to them a one-sided and pessimistic meaning. Particularly does he misapprehend the intent of Christ in his command to "take no thought for the morrow," making it to enjoin, as he says, "an utter disregard of self" and a putting away of provident foresight, such as characterizes every thoughtless beggar and lazy tramp!

Now, every tyro in Greek knows that the word (μεριμνήσητε) translated "take no thought" does not refer merely to mental action, but rather to emotional concern, that which is accompanied by pain and trouble, so that Christ only interdicts that overweening anxiety and distressing thoughtfulness which many indulge, and which not only is opposed to a simple faith in divine providence, but emasculates the heart and unfits one for effort even toward his own good. Thus the Teacher virtually enjoins a rightful egoism.

Paul did not construe Christ's command as does Mr. Smiley, for he enjoined a proper foresight in saying that "if any provide not for his own" (the Greek being τῶν ἰδίων), for his own private, personal, and particular interests, "and especially for those of his own house, he hath denied the faith and is worse than an infidel." What stronger egoistic teaching than this could any one wish? This self-providence Paul implies in his command to the Roman Christians that they should be "not slothful in business," which is in accord with Solomon's precept, "Go to the ant, thou sluggard." Thus, Mr. Smiley has not had regard to the comparative teachings of the Bible, as well as to the true signification of its original terms.

He affirms further that Christ's declaration of a simple fact, that "the poor we have always with us," was very "*unfortunately*" said. Now, not even assuming any divine quality for Christ, but simply admitting him to be a man of profound wisdom and far-seeing philosophy, how could his statement, contrary thereto, have been *unfortunate?* Mr. Smiley, however, puts this phrase about the ever-presence of the poor as approving and commending their condition, while indeed it simply states an inevitable and incontrovertible fact, growing more and more so, in each successive age, not because Christian self-denial and altruistic charity have produced this result, but because increasing and crowding populations and social vices, especially

in the world's great cities, with multiplied luxuries, present temptations to self-indulgence and idleness, ultimating in poverty.

If, as Mr. Smiley asserts, the benevolent methods of relieving the poor have not diminished their number, it is evidently due not to such altruism but to these antagonistic causes. Can he prove that such benevolence has *not* legitimately tended, in any measure whatever, toward the checking of such evils as lead to poverty, and to the forestalling of such corruptions as ruined the republics of Greece and Rome as well as other great nationalities? Just here Mr. Smiley does not recognize the clear logical distinction between a mere occasion and an efficient cause—between an incidental result and a legitimate effect. Pro-slavery men, both at the North and the South, failed to make this distinction when they declared that the anti-slavery men brought on the rebellion, and that therefore they were the culpable cause of it. No! Slavery itself was the cause—the abolitionist was only the occasion. The one worked for evil, the other for good: if evil came through the latter, it was but incidental, not legitimate. Every system, however excellent in itself—not being perfect, of necessity—implies or involves occasional ills. Is Mr. Smiley logical in making the incidental results of altruism, as evil, its necessary and legitimate effects? Is it a causal force to human ills? Granting, indeed, that some among the poor have abused gifts and become idlers, has this been the universal fact? Has charity always made beggars and tramps, or are such only sporadic and exceptional cases, while, to a large extent, social benefits and industrial results have come from individual and organized benevolences? Does not Mr. Smiley reason illogically and with a pessimistic spirit, taking only a few isolated and unfavorable facts and the worse aspects of the case from which to draw a general deduction?

While, indeed, his argument rightly prevails against a heedless and indiscriminate benevolence, it does not appertain to careful and systematic giving. All properly organized institutions and all thoughtful schemes of benefit to the poor take into consideration and aim at the improved industrial condition and moral advancement of their beneficiaries. Such organizations are designed and formed to operate for the very end of rendering beggary dishonorable and unprofitable, and for inspiring the poor with industrial self-respect. They say to the charitable man, "Do not give promiscuously, but through the medium of those agencies which have regard to the elevation as well as the relief of the poor."

If, as Mr. Smiley assumes, the improvidence and demoralization of the poor are the legitimate effects of charity working as an efficient cause, then, of course, it is a curse. But this is not the case. Rather the primary causes are the ignorance, the illiteracy, the prodigality, and the lack of moral training among the poor, as well as bad legislation and tempting surroundings. To charge all this upon a self-denying charity is logically wide of the mark.

The first argument which Mr. Smiley offers against orphan asylums is that "moral corruption, brought in a little by each child, leavens the whole lump." Here he assumes that each child necessarily brings in more or less corruption, and therefore he presumes that no orphan has any inherent purity, which is a virtual admission of a native depravity such as he would, perhaps, be far from positively asserting. As a general rule, children are received into orphan asylums before they are old enough to carry corruption into them. If this argument of Mr. Smiley has any real force, it must equally prevail against all schools, private or public, against families and neighborhoods in which children of different ranks and characters come into close personal contact with each other, and are more or less good or evil. Would Mr. Smiley isolate these children and segregate such communities? Does he not know that in all these orphan asylums moral and Christian teaching is often more clear, pronounced, and effective for the good of the child than may be found in many a school or household? Is it not most likely that, where one or two children may prove corrupt, the moral tone of the many, under right training, would tend to counteract and correct the evil of the few?

In his second argument against these asylums Mr. Smiley assumes that only incompetent teachers are employed in them, and, as if in proof of this, he asks, "Who ever knew a scholar reared in an orphan asylum?" Well! who ever heard of one reared in a State-prison, a factory, or a coal-mine? Who ever expected orphan asylums to turn out scholars? Was this the design of their establishment? But, in answer to this charge of Mr. Smiley, it may be truthfully said that not all, and indeed very few teachers in such institutions are incompetent. They stand, generally, on a par with those of our public schools, some of them being men and women of education and refinement, who, from pure love of children and their moral good, devote themselves, in some cases gratuitously, to such benevolent work. Mr. Smiley can scarcely have studied the histories and statistics of orphan asylums, or he would not have charged upon them bad food, poor training, and rejection from good families, in respect to all which it may be shown unquestionably that he is sadly mistaken. Neither would he have ignored the fact that the children of drunken fathers and mothers are not usually taken into *orphan* asylums, or, if they ever are, then they are saved from the horror and ruin of a drunkard's home, in which every true philanthropist should rejoice.

As to "foundling asylums," Mr. Smiley is still more severe, asserting that every one "in America should be instantly disorgan-

ized"! On what ground? Because, he says, "they encourage crime"! But does the vile man or frail girl, committing evil, pause beforehand to deliberate how the possible fruit of the crime is to be taken care of? No! any such consequence is not thought of; if it were, that would be a restraint upon immoral tendencies. But Mr. Smiley can be shown some "foundling asylums" where poor but virtuous women have found homes for their true children, when they have not been able to provide for these, or have been out at labor in families and factories, especially when their husbands have been sick, feeble, or vicious, and therefore could not provide for their legitimate children. Would Mr. Smiley deny to such women so great a privilege?

As to the encouragement of immoral girls, I can point Mr. Smiley to one "foundling asylum," at least, in Chicago, originated by Dr. George Shipman, a homœopathic physician, who assured me that only about one in a hundred women, coming with their babes, could be regarded as essentially criminal. They were either unfortunate wives or deceived girls, who, having received at the asylum proper instruction, were taken into respectable families as domestics. Rarely did one such fall, especially as the restraint was put upon them tnat a second lapse would forbid their return. Would Mr. Smiley disorganize such an institution? Would he break up Mr. Müller's great establishment in Bristol, or that of Dr. Cullis in Boston, wherein many have been housed, fed, comforted, and rightly trained, fitted for death or for usefulness in life, and from which so many rescued victims of poverty and distress have gone forth into the world to find success and honor?

If Mr. Smiley had consulted the records of education societies, he would have found, what any one of its secretaries, I know, would have told him, that scores and even hundreds of thorough female teachers and distinguished pulpit orators have been the happy and successful beneficiaries of such societies. Their statistics plainly show this. The one sporadic case to which he refers is an individual and marked exception to the general rule and does not justify a broad deduction as to the evil of those organizations. "One swallow does not make a summer," neither does one snow-flake make a winter.

In pressing "egoism" to the exclusion of "altruism," or to its disparagement, Mr. Smiley would feed that natural selfishness which is common, more or less, to all men, and which, unrestrained, tends to such extremes as bring vast misery to mankind. He thus antagonizes that law of love which is the rhythmic force in the moral world. A great Teacher said, "Thou shalt love thy neighbor as thyself"—no more, no less. He here brings altruism into juxtaposition with egoism. They are counterparts and correlatives, each essential to the other. As in the solar system the centripetal and centrifugal forces keep its orbs apart and in space with equilibrium, so these two forces of egoism and altruism balance each other, and promote the harmony of society. As in physical science both the positive and negative poles of the battery are needed for the generation of magnetism or electricity, so these two moral poles must be coincidently present and work together to the production of moral magnetism for human benefit. As in logic, induction and deduction, according to Sir William Hamilton, are not antagonisms, but, if not identical, are certainly counterparts, the one reciprocally leading to and involving the other—so are egoism and altruism; they are associative and co-operative. Common love binds them together; common interests, as with all human associations, bring them into unity of thought and action for the greatest mutual good. Once, Wendell Phillips, speaking of capital and labor, said, "They are twins—Siamese twins—bound together by a living ligament, to cut which would be to kill both." They are interdependent, vitally united. So with egoism and altruism. They need each other for true existence and right action. Egoism alone runs to selfism; altruism alone to fanaticism. Together, they are mutually compensative—apart, destructive. Of the two in union, the words of Shakespeare's Portia may be predicated: "It blesseth him that gives and him that takes." That union fulfills Christ's words: "Give and it shall be given unto you, good measure, pressed down and shaken together and running over, shall men give into your bosom. For, with the same measure that ye mete withal, it shall be measured to you again." In these words, egoism and altruism are pronounced correlative and compensative. Does not the patriot feel rewarded fully when dying for his country? Does not the martyr, though suffering physically, rejoice thus to maintain truth? Does not the benefactor, like a Slater or a Hand, giving his millions for the education of an ignorant and despised race, feel assured of due return? If the arguments of Mr. Smiley were carried out practically to their ultimate and logical results, then all such patriots, martyrs, and benefactors must be relegated to the realms of folly or forgetfulness. Then the egoistic Alexanders and Napoleons must have exaltations above all Howards, Wilberforces, Garrisons, and Caroline Frys.

May it not be suggested that Mr. Smiley has taken rather a one-sided, prejudiced, and pessimistic view of his subject? Has he not failed to take note of abundant and palpable facts controverting his positions? What if the altruism he condemns be banished from society? What then would the world do without the multitude of noble, self-sacrificing men and women whose love of humanity has led them into the deep, dark slums of

our great cities for the rescue of the perishing; who have suffered themselves to be socially ostracized by teaching the black children of the South; who have dared the Mormon monster in his den, to extirpate the curse of polygamy; who have dwelt in Indian wigwams to civilize the savage; who, for medical science or society, have breathed the infections of small-pox or yellow fever; or who, like Livingstone and Stanley, have penetrated the wildernesses of Africa for the suppression of the slave-trade? Shall it be said to all such: "Renounce your altruism and rest in your egoism; self-sacrifice is not wisdom, beneficence is not profit"? Shall it be said to all founders of hospitals, as well as asylums, of colleges like Harvard, Yale, Cornell, and Johns Hopkins, with their scholarships, "Ye are the monuments of altruistic error"? Shall it be said to benevolent and moneyed men, who can not personally work for humanity: "Hoard your money; waste it not on charities"? Is their benevolence to be smothered by the smoke of eleemosynary institutions which the egoistic torch would consume?

Truthfully yours,

C. H. A. BULKLEY.

HOWARD UNIVERSITY, WASHINGTON, D. C.

THE WORK OF THE BURROWING RAT.

Editor Popular Science Monthly:

IN your November number there appears an article, by Prof. N. S. Shaler, entitled "Habits of the Great Southern Tortoise," which is based upon premises so manifestly erroneous that it is difficult to understand how the professor could have been led to adopt them; and, therefore, in the interest of science, I take the liberty of pointing out to him, through you, the error which he has made. Having lived in Florida for several years, and having during that time closely observed the habits of the land-tortoise, or so-called "gopher," to which the professor refers, I know whereof I speak. The professor is entirely mistaken in supposing that the little mounds of sand which he describes are made or pushed up by the *tortoise*, or "*gopher*." They are the result of the industry of quite a different animal, viz., a species of *burrowing, pouched rat*, known in eastern Florida as the "salamander."

The land-tortoise, or gopher, *never* burrows into the earth beyond a distance of *ten* or *fifteen feet*, where he goes merely for concealment, not for food. He never obstructs the outlet of his burrow, but keeps it open, so that he may readily return to the surface of the soil to seek grass and other vegetable matter, upon which alone he subsists. It is true that he hibernates during the winter months. I have caught hundreds of "gophers," and have shot or caught in traps dozens of the "salamanders," and I am prepared to substantiate what I have here stated in the most indubitable manner. It is manifestly a physical impossibility for the *tortoise* to burrow its way thousands of feet horizontally under the ground, as the professor supposes.

I can easily imagine the amusement which Prof. Shaler's article would afford residents of Florida, should it reach their eye. Such inexcusable errors in scientific papers are not calculated to bring honor to science or to the scientist. Very respectfully,

C. C. BYRNE, M. D.

WASHINGTON, D. C., *November* 1, 1888.

[In a former paper, referred to at the beginning of the article on the "Southern Tortoise," Prof. Shaler mentioned the disturbance of the soil due to burrowing rodents. The second article was devoted wholly to the work of the tortoise, but does not seem to us to conflict with the statement that other animals produce effects of this sort in Florida, even exceeding in some localities those produced by the tortoise.—EDITOR.]

A DOG THAT COULD COUNT.

Editor Popular Science Monthly:

ON page 123 of your November number Dr. A. S. Hudson relates incidents to show that animals may be able to count. In 1868 an Omaha printer, named Bolster, owned a terrier bitch that could count. On being told by her owner to climb a certain number of steps and lie down, she obeyed, never making a mistake, although the task given was varied so as to test her ability. She gave evidence of equal intelligence in other directions, and there is no doubt that she could actually count up to fifteen.

Yours, etc., J. D. CALHOUN.

OMAHA, *October* 24, 1888.

THE TYPE-WRITER FOR THE BLIND.

Editor Popular Science Monthly:

IN an interesting article on "Writing-Machines for the Blind," published in "The Popular Science Monthly" for September, I was surprised to see no mention made of the type-writer as having been utilized for that purpose; and, as the author seemed thoroughly acquainted with his subject, he would doubtless have noticed the fact had it ever been used.

From the readiness with which the blind learn to manipulate the keys of the piano, it is to be presumed they would have no difficulty in managing those of the type-writer—a process which could be still further facilitated for them by having the letters on the keys raised. The printing type could be beset with sharp points, so as to prick out the letters on the sheet instead of printing them with ink, and, by using paper of the proper thickness, a distinct raised let-

tering would thus be made, which the blind could decipher by feeling.

It is true, the printing would be reversed, but in spite of this the type-writer for the blind would have advantages which, it seems to me, no other instrument of the kind yet invented possesses.

E. F. ANDREWS.

MACON, GA., *November* 1, 1888.

[Ordinary type-writers are used by hundreds of blind operators for writing to seeing persons. A blind person, having once learned the arrangement of the keys, has little difficulty in operating the instrument. This is one of the uses proposed for it by the inventor of the earliest form of type-writer, Charles Thurber, in 1843, and one of his machines is now in existence which had originally raised letters on the keys to facilitate such use. In order that the printing shall be legible to the blind, of course some mode of pricking or embossing the paper would have to be employed, and the reversing of the print, to which our correspondent alludes, could easily be obviated by reversing the type.—EDITOR.]

THE EXTENSION OF THE SUFFRAGE TO WOMEN.

Editor Popular Science Monthly:

IN Prof. Cope's "Relation of the Sexes to Government," in the October number of the "Monthly," he makes intellectual inferiority, physical inability, and the social position of woman the practical objections to granting her the "privilege" of suffrage, and favors its restriction rather than an extension.

But even if men are on the whole superior to women, the difference is not so great but that, if the same restrictive process were applied to women and men, a considerable minority of the women would fulfill the conditions which a not very large majority of the men could fulfill. Although any system of suffrage can only be an approximation to what might be best, it is a poor approximation indeed that will shut out a large minority of one sex because the majority of that sex fail to fulfill the qualifications for suffrage. That is majority-rule with a vengeance.

It is declared that "woman suffrage becomes government by women alone on every occasion where a measure is carried by the aid of woman's votes." Then government by a successful party, whose candidate is elected by a majority of one thousand in a "deciding State," becomes government by five hundred and one men; and government everywhere becomes government by the smallest possible majority of the majority by which a party elects its candidate. What becomes of popular government? It is further declared that, if women vote with their husbands, suffrage becomes a farce. It is a very plain social fact that men who associate much come to think alike, especially on subjects that are much thought upon. Like teacher, like student; like father, like son. Politics runs in families almost as much as features do. If all who acquire their political leanings from their constant associates shall not vote, a very large majority of the sons of the country must be disfranchised, and in a generation there will be no voters at all. And if the women of the land, by exercising suffrage, run the danger of becoming the mothers of a "generation of moral barbarians," are the fathers of the race so entirely different in quality from the mothers that the transmission of a very large amount of barbarism might not be prevented by a wholesale restriction of the suffrage?

Physical inability to execute the laws when they are made, and to defend them in a military capacity, is made a principal objection to the granting of suffrage to women. "This consideration alone, it appears to me, puts the propriety of female suffrage out of the question." But only a small proportion of men are willing to be executors of the law, as policemen and sheriffs; and, as for the judicial positions, an even smaller proportion is *fitted* to fill them. Restriction of the suffrage would be a good thing; let it be applied under the principle of immunity from military service, and who would be disfranchised? War demands able-bodied men; only men that are perfectly regular in form and sound in health can be soldiers. If immunity from service is to form the boundary-line of suffrage, all the rest, a vast number, would be shut out. This excluded list would include perhaps the best class of voters the nation has—the older men—because they are exempt from military duty. But I am sure the professor himself would be unwilling to begin restriction under the principle he has enunciated, and reduce the elders of the nation to the condition of Gulliver's Luggnaggian *struldbrugs*.

FRANK CRAMER.

APPLETON, WIS., *October* 10, 1888.

EDITOR'S TABLE.

THE MARCH OF PRACTICAL SCIENCE.

IT is idle to be continually repeating that this is a very wonderful age; but we may with good reason congratulate ourselves that science has now reached a point that insures to the human race an ever-increasing mastery over the powers and resources of nature, and that ought, with any kind of right management, to be productive of better modes of life from year to year, not for the few only but for all. At the last meeting of the British Association an address was delivered by Mr. Preece, President of the Section of Mechanical Science, which, though confined to the single subject of the recent advances in the practical applications of electricity, furnishes a vivid picture of the changes which scientific knowledge generally is working in the world. Things that to our forefathers were perfect types of the unknowable, are to-day, as Mr. Preece remarks, among the best-understood of natural phenomena, if not in relation to their ultimate cause, at least in regard to the laws of their operation. Among the various troublesome questions asked of the patriarch Job was one as to whether he could send lightnings, so that they might come and go at his bidding. Of course, Job had to give it up; but that was not because the problem was absolutely insoluble, but because he had not the scientific knowledge necessary to solve it. To-day lightnings are flying to and fro in most complete subjection to the will of man; and even the free lightnings of heaven have to a large extent been placed under bonds to do him no harm. Mr. Preece antedates, we observe, by five years the classical experiment of Franklin with the electricity of the clouds, placing it in 1747 instead of in 1752; but he is correct in stating that nearly a century elapsed after Franklin's great discovery before, as a working power, electricity was fairly mastered. Naturally the Church was opposed to the study of electricity in its beginnings; but that study has been too fruitful of beneficial results, and too victoriously successful all along the line, to remain under a ban of any kind. Churches themselves are now protected by lightning-rods against random thunderbolts, just as the clergy, in common with other classes, are protected by vaccination against small-pox. On the subject of lightning-rods, Mr. Preece's declaration that "as long as points remain points, as long as conductors remain conductors, as long as the rods make proper connection with the earth, lightning protectors will protect," is a word spoken in season; as also is the caution he goes on to give as to the neglect of the conditions upon which the whole efficiency of the system of protection against lightning depends.

It would be impossible within our limits to give anything like a satisfactory summary of the very interesting address to which we have referred. Two or three points may, however, be singled out for notice. The electric telegraph may now be said to have been in use for business purposes for half a century. The rate of transmission at the outset was five words a minute; to-day it is six hundred. Cooke and Wheatstone required five wires for their first needle instrument, which worked only at the rate of four words a minute; whereas one wire now conveys six messages simultaneously at ten times the speed. On the 8th of April, 1886, now nearly three years ago, when Mr. Gladstone introduced his Home-Rule Bill in the British House of Commons, no less than 1,500,000 words were sent over the wires from the Central Telegraph office in London. Mr. Preece seems to approve of the purchase of the telegraphs by the British Government. He

states that the telegraph business which, when assumed by the Government in 1870, brought in £550,000 per annum, now yields £2,000,000 per annum; and that the annual number of messages has increased from 6,000,000 to 52,000,000. What the increase in revenue and work done would have been had the telegraphs remained in private hands, it is impossible to say. Government telegraphing is cheap—6*d.* for a message to any part of the United Kingdom—and that, no doubt, tends to make it popular. Mr. Preece refers with natural pride to the leading part Great Britain has taken in the laying of submarine cables. British ships, he states, have laid 110,000 miles of cable; and British capital to the amount of £40,000,000 has been expended in this very useful work. The railway system of to-day could not have reached its present development without the aid of the telegraph, by means of which the whole movement of trains is checked and controlled from moment to moment. A well-equipped signal-box on a main line of railway is a very interesting place to visit. To quote the words of the address: "The signal-man is able to survey the lines all round him by the aid of his electric signals; he can talk by telegraph or telephone to his neighbors and his station-master; he learns of the motion of the trains he is marshaling by the different sounds of electric bells; he controls his out-door signals by the deflection of needles or the movement of miniature semaphores; he learns the true working of his distant signals by their electric repetition; machinery governs and locks every motion that he makes, so that he can not make a mistake." The safety thus secured for the traveling public is indicated by the fact that in the whole United Kingdom the average annual loss of life by railway accidents in the five years ending 1887 was only sixteen, or, as Mr. Preece computes it, one life to every 35,000,000 journeys made by train.

Great inventions have often a considerable period of incubation before they assume their proper importance and development. Thus, nearly seventy years elapsed between the discovery of the electric light by Sir Humphry Davy and its practical introduction for purposes of street-lighting. Mr. Preece is enthusiastic for the electric light, which he contrasts in its purity and wholesomeness with "filthy gas and stinking oil." He states that in the Central Savings-Bank, at London, the introduction of the electric light was followed by an appreciable improvement in the health of the staff. Every year sees some increase of efficiency or diminution of cost in connection with this admirable system of lighting. At this moment it is beyond comparison the cheapest method of producing any given unit of light. For the working of tram-cars or street-railways, Mr. Preece is of opinion that electricity is incontestably the agency destined to be most extensively used in the near future. In saying this he has in view the climatic conditions of the British Isles; but there is good reason to expect that experiments now being made in this country will demonstrate that, even where snow-storms have to be contended with, electricity will carry the day in the contest with horse-flesh. The progress made in the electrolytic extraction of metals from their ores is shown in the fact that whereas not long ago it was considered economical to absorb 0·85 horse-power in depositing one pound of copper per hour, the same work can now be done with 0·3 horse-power. The uses, however, of electricity are almost beyond enumeration. We have electric welding, electric production of chlorine, iodine, and oxygen, electric decomposition of poisonous gases, electric fire-alarms and frost-alarms, electric photography, electric bells, electric clocks, electricity as a curative agent, and electricity as a substitute for hanging. The question as to what electricity is, or how it may be most correctly defined, will

probably continue to furnish matter for debate for some time to come. Mr. Preece finds fault with those physicists who object to recognize in electricity a form of energy, and insists that the engineer has a right to speak of electricity as he finds it, and therefore to speak of it as "energy." This is a dispute into which we can not enter further than to say that the arguments urged by Mr. Preece do not seem to us to touch the position of the physicists. We are with him entirely, however, when he says that "the engineer feels that steam and electricity in his hands have done more to economize labor, to cheapen living, to increase wealth, to promote international friendship, to alleviate suffering, to ward off war, to encourage peace, than all the legislation and all the verbosity of the politician." It is satisfactory to think that, while science is being railed at in certain quarters, its methods are being ever more fruitful of good to mankind. Science is doing its part nobly in the world, and, if moral results do not seem to keep pace with the enlightenment of the age, that should be a matter of special concern to those who feel themselves responsible for the moral interests of the community. May it not be reasonably said that, if they would do their work as well as the man of science is doing his, an equal success would crown their labors? It is all doubtless a matter of the adjustment of means to end; and, when the right means are employed in the moral sphere, we may expect to see there a progress not less marked than that which is now taking place in theoretical and practical science.

THE ABUSE OF EXAMINATIONS.

No more timely or important document has been given to the world, of late years, than the protest reprinted in our present number from the "Nineteenth Century," on the subject of the sacrifice of education to examinations. The protest in question is signed by the leading educators of Great Britain, and by many others eminent in science and letters. It is re-enforced by separate articles by England's greatest philologist, Prof. Max Müller; her greatest historian, Prof. Freeman; and her most brilliant and philosophical essayist, Mr. Frederic Harrison. All these men see clearly that a great intellectual and moral injury is being done to the nation by an excessive use of examinations, and, generally, by an excessive stimulation of the work of education. The universities do their own share of mischief by offering large pecuniary prizes as the rewards of proficiency tested by examinations. The Government helps on the evil cause by making access to the public service a simple question of "marks." Teachers obtain their positions and schools their grants in the same way; while the unfortunate pupils are having their studies continually interrupted in order that some one may grub at the roots of their growing knowledge for the purpose of spying out how weak a thing it is, and, in doing so, making it still weaker.

The philosophy of the whole business is simple enough. So long as the intellectual development of a country is following a simple, unforced course, education will be pursued for the sake of the essential benefits it brings; and educators will think chiefly, if not exclusively, of the true intellectual interests of their pupils. There will not be a feverish anxiety to ascertain the precise results achieved at a score of different points in a course of instruction. It will rather be taken for granted that only those who desire to profit will seek instruction, and that the result of their studies will appear in some spontaneous form in later days. If questions are asked, it will be for the sake of exciting intellectual interest, or of giving an opportunity for diversities of treatment of a certain topic. It will not be done in the spirit of the highwayman who offers you the alternative of surrendering your money or your life. But when once a

"great public interest" has been awakened in education, and the Government has "taken it up in earnest," and grants of money become available for schools that can earn them by passing a certain number of pupils through certain grades, then the whole spirit of education becomes changed. The student's one ambition—if he has any at all—is to pass an examination, the teacher's is to get as many of his pupils as possible to pass as many examinations as possible; and to these wretched ends the whole work of the school is made subservient. There is no time allowed for reflection or for the slow gathering of results, none for the enjoyment of what is learned, none for the gathering of wayside illustrations; all is hurry and press, strain and stress, business from the start and business to the close. The result is, the all but complete extinction of true intellectual interests. Our young people do not learn to love knowledge for its own sake, for any sense of mental enlargement that it confers, or for any benefit that it enables them to bestow on their fellows. They hardly have time, indeed, to realize the difference between what is real and vital in knowledge and what is its mere outward husk or shell; and they leave school in thousands with intelligences blunted rather than sharpened, and—we grieve still more to think—with moral sensibilities dulled rather than quickened, by the routine to which they have been subjected.

Some may hold that we overdraw the picture; but there can hardly be a doubt in the mind of any liberally cultivated man or woman that the evil to which we refer, and on which the signers of the "protest" that has given rise to our remarks expatiate, is a very real one. We trust sincerely that the whole subject will receive a very thorough discussion, and that, in our own country, there will prove to be a sufficient force of enlightened public opinion to introduce at least some partial reforms. More than this, in an essentially state-directed system of education, we dare not hope for.

Our readers who have followed the "New Chapters in the Warfare of Science," by Dr. Andrew D. White, as they have appeared from time to time in the "Monthly," will be glad to learn that the publication of this unique series will be resumed in the February number. These papers are characterized by novelty, pith, and scholarly research. Dr. White has devoted several years to the investigation of his subject, and is now in Europe, examining the libraries and collections of antiquities for additional material. This research, which the author is making unusually exhaustive, can not fail to bring out many facts and incidents in the history of dogma and superstition which have never before seen the light, or have been buried in obscurity for centuries. With such resources at his command, Dr. White is in a position to lay before his readers some very remarkable illustrations of the persistent dominance of delusion in the human mind. But much more than this superficial interest is aimed at, for the author hopes by the publication of these papers to start some trains of thought among reflecting men which shall be of permanent service alike to Christianity and to science. The chapters immediately forthcoming will treat of the subject of "Demoniac Possessions and Insanity."

LITERARY NOTICES.

English Composition and Rhetoric. Part II. Emotional Qualities of Style. By Alexander Bain. New York: D. Appleton & Co. Pp. 325. Price, $1.40.

The discussion of the subject of this volume is considerably amplified from that given in the original work, with a more precise classification and fuller detail of examples. The subject is confessed to be beset

with peculiar difficulties, arising from the vague and indefinable character of the human feelings, which can not be described directly or accurately analyzed; it can be approached only by the way of wide comparison and illustration. The first step taken by the author is to classify the emotions common to poetry and the fine arts; and in this we find at the outset that the lines are hazy and discernible only by the aid of acquired faculties. Next to be studied are the aids to emotional qualities, the common end of which is the evoking of emotions of the pleasurable kind. The conditions of treatment under which they are brought into effect are representative force, concreteness and objectivity, personification, harmony, ideality, novelty and variety, plot, and refinement. The qualities themselves are designated as strength or sublimity, beauty, feeling or pathos, humor, wit, and melody; of which melody and feeling are perhaps the least ambiguous, while most of the others are liable to complications that make scientific precision in the language of criticism very difficult. Under the first head are brought the contrasted emotions of love, tender feeling, and sociability, on the one hand, and irascibility, malevolence, and antipathy on the other. It may seem paradoxical to enumerate the emotions of the latter category among the promotives of pleasure, but an analysis of the best literary works will show that these darker aspects of feeling are as essential as the shadows in a picture. Feeling includes the varieties of love, friendship, patriotism, compassion, religion, personified feeling, and sorrow or pathos; humor, the group of qualities centering in the ludicrous. When place is given to all these qualities, there still remains a region of effects not fully accounted for—beauty; the sense qualities; utility, which can hardly be divorced from the special emotions, but stands to a certain degree remote from any one interest; and imitation, which lends itself to further the special qualities, but has also an independent charm. Next to the minute and methodical treatment of the emotional qualities, the chief peculiarity of the present work is the line-by-line method of examining passages with a view to assigning merits and defects. These passages occupy a considerable proportion of the space, and are representative, both of the rhetorical qualities which they illustrate, and of the classical authors of all times, including the best-known contemporary authors of the literary nations. This feature, while completing the value of the book for study, makes it also attractive for leisurely reading.

REALISTIC IDEALISM IN PHILOSOPHY ITSELF. By NATHANIEL HOLMES. Boston and New York: Houghton, Mifflin & Co. In Two Volumes. Pp. 521 and 499. Price, $5.

STARTING with the presumption that man aspires after and must have some theory of himself, of the universe in which he lives, and of life, duty, and destiny in it, the author disposes of all the ancient theories—intuitional systems, he calls them—as vague and not competent to stand the test of a truly philosophical criticism. But the stream of thought and light that poured through antiquity, gathering strength from the various ethnic sources by which it was fed, was transmuted "into the learning and wisdom of the Christian era, such as they have been." Exactly how much the knowledge or culture of the present time has been indebted to either of the ancient systems, or how much to those of the Christian centuries alone, it would be difficult and perhaps unimportant to specify. "The one most certain thing of all is that the knowledge of nature, the insight into any true theory of this universe, or into any true wisdom in the conduct of life in this world, or into any assurance of life hereafter, that has been gained within the last five hundred years, is of more worth and value to mankind than all the rest put together." The modern speculations of philosophical theists are declared to have been too much biased by preconceived notions concerning biblical revelation, by influences growing out of reverence for Christian beliefs and popular opinion, or by subjection to an established church, to be of the value that they should be. The class of writers of which Voltaire may be taken as a representative—being mainly literary and iconoclastic—have failed to present a statement of universal philosophy or a conception of the Deity that need detain much the critical thinker of this century. Scientific methods deal

with facts as facts, and are not directly concerned about a theory of God or the universe. "Physical science is a kind of external ladder by which the human mind endeavors to ascend, step by step, to the topmost height (as it were) of all knowledge. The higher it mounts, the more certain it is to find itself entering into the still higher realm of the internal and metaphysical, ending only in the universal and absolute." A metaphysical system is likewise insufficient without the verification of its conclusions by a thorough science of external nature. If philosophy has hitherto failed to furnish a satisfactory theory, the greater is the need that it should still endeavor to accomplish it. A condition is that "it must be able to take up all science, all nature, all humanity, into clear solution, leaving nothing out, or nothing but nothing." Of the four theories of the universe that stand before the world for consideration, the biblical-supernatural theory leaves philosophy to become impossible and impertinent; the materialistic-machine theory has no room for anything but physical science; and in the mystical-idealistic theory—which supposes that we have no certain knowledge of external nature, but only of the ideas or images which are formed in our minds on sensation and sense-perception—the business of philosophy is to make it as intelligible, credible, and acceptable as possible. The realistic-ideal theory, or realistic idealism, which gives the name to the book, holds that the real and the ideal are not two distinct worlds, but only the two sides or aspects of one and the same whole actuality of real essence and power. "Its method is both analytical and synthetical, is neither exclusively dialectical and deductive, nor wholly experimental and inductive, but is both at once; it is, in short, the universal method of the metaphysical logic which takes up all science into intelligible and clear solution." It is the purpose of the work to unfold, explain, and establish this theory. The book is a hard one to read, but the difficulty lies in the nature of the subject, and the fullness of the author's thought, requiring corresponding fullness in expression, and not in any defect of the workmanship. The author has studied the subject, and has mastery of his thought and knowledge of what he wishes to say.

THE TENTH AND TWELFTH BOOKS OF THE INSTITUTES OF QUINTILIAN. With Explanatory Notes. By HENRY S. FRIEZE. New edition, revised and improved. New York: D. Appleton & Co. Pp. 294. Price, $1.40.

THE value of Quintilian in classical study consists in the opportunity which his work furnishes for at once getting knowledge which has a direct bearing on professional life, and for attaining a higher scholarship in the Latin language. The *Institutio Oratoria*, or "Education of the Orator," is an invaluable contribution both to polite literature and to liberal education, and capable of being made practically useful to young men in their preliminary training for public life. The tenth and twelfth books are selected for the purposes of the present text because of the interest and importance of the topics discussed in them: the former book relating to the practical studies and exercises that contribute to the formation of a good style, and the twelfth presenting a kind of outline of what the character and life of an orator should be. Prof. Frieze's work in this preparation is based most largely on the labors of Prof. Bonnell and those German scholars who have given most attention to Quintilian. The present new edition has been revised in view of the later labors of Carl Halm and G. T. A. Krüger; and the notes have been amplified, with the view to making them helpful wherever help may seem to be needed.

ANTIQUITIES OF THE STATE OF OHIO. By HENRY A. SHEPHERD. Cincinnati: John C. Yorston & Co. Pp. 139.

THIS monograph is a portion of the author's "Popular History of the State of Ohio." It deals with the ancient inclosures, mounds, *caches*, tombs, etc., located in that State, and the objects found within them. In Ohio alone there have been till recently not less than ten thousand mounds and from fifteen hundred to two thousand inclosures. In other parts of the Mississippi Valley they are so numerous that no attempt has ever been made to count them all. The inclosures are usually regular in outline, and vary in size from an acre or less to three hundred and fifty or four hundred acres. Most of them appear to have been designed for religious purposes, while others were appar-

ently places of defense. The mounds have been classified as sacrificial mounds, mounds of sepulture, temple-mounds, and anomalous mounds. To these may be added the effigy-mounds, of which there are only three or four in Ohio, the most remarkable of them being the "Great Serpent" mound. In his descriptions of these works and the objects found in them the author quotes frequently from Squier and Davis, and from later explorers recognized as authorities on this subject. Plans, diagrams, and views illustrate the text.

HYGIENE OF THE NURSERY. By LOUIS STARR, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 212. Price, $1.50.

THE object and spirit of this book can not be better expressed than in the following extract from its preface:

> Having a firm belief in the proverb that "an ounce of prevention is worth a pound of cure," the author has endeavored, in the succeeding pages, to point out a series of hygienic rules which, if applied to the nursling, can hardly fail to maintain good health, give vigor to the frame, and so lessen susceptibility to disease. He feels, too, that intelligent parents are ever ready to be instructed and willing to co-operate in the great work of preventing disease —the highest aim of scientific medicine. While every woman of ordinary brain-power can do much to keep her baby well, she should recognize that years of training and experience are necessary to acquire the ability to put the full value upon symptoms, and to handle the tools of medicine. Therefore, little or no reference has been made to drugs or methods of medical treatment.

The first chapter, describing the normal appearances of the infant in health, is written with the object of hinting to the mother when by deviations from such conditions she may be apprised of the onset of disease, and call in professional counsel. The last chapter, on emergencies, is offered as a guide in cases where immediate action will save much pain and danger. Besides ordinary accidents and disorders, those which occur only at birth or soon after are treated of, and directions for making various poultices and plasters are given. The other chapters tell how to manage everything that affects the every-day life of the infant. The choice and furnishing of a room for the nursery, the selection of a nurse-maid, the infant's clothing, exercise, and amusements, sleep, bathing, and feeding, are all treated with full details. The subject of food occupies the most space, and recipes for preparing quite a variety of foods are given. Throughout the volume the directions are clear, simple, and complete, and the expectant mother who possesses this book, with a fair share of common sense, is well equipped for the care of her baby.

THE VIRTUES AND THEIR REASONS. By AUSTIN BIERBOWER. Chicago: George Sherwood & Co. Pp. 294. Price, $1.35.

THIS book is designed both as a treatise for the general reader and as a text-book of ethics for schools. In arrangement, it follows a classification of duties which divides them first into duties regarding others chiefly, and those regarding self chiefly. The five subdivisions of the former class are: kindness, truth, honesty, family duties, and public duties. Duties to self comprise self-development, industry, self-support, self-control, temperance, self-respect, purity, and conscientiousness. "Moral instruction is often excluded from the public schools," says the author, "on account of the different religions represented, and the want of text-books acceptable to them all." Hence he has purposely adopted such a method of treatment that "Catholics, Protestants, Jews, and unbelievers may use this book with equal approval." He does not go into the question what constitutes right; "it is enough now to observe," he says, "that, whatever men's opinions touching the ground of right, they all deem those things right which are thought best for men, and consider that course morality which will bring them most happiness." Accordingly, the matter under each head throughout the book may be described as a statement of those things which are thought best for men. The volume is without an index.

THE ADVANCE-GUARD OF WESTERN CIVILIZATION. By JAMES R. GILMORE (Edmund Kirke). New York: D. Appleton & Co. Pp. 343. Price, $1.50.

THIS volume has a close relation with the two previous historical works by the same author—"The Rear-Guard of the Revolution" and "John Sevier as a Commonwealth-Builder," the three together presenting, as is remarked, a phase of American history to which sufficient prominence has not been given—the story of the foundation and

growth of the Tennessee commonwealth. The title of the first volume is justified in the fact that, but for the enterprise and courage of the hardy pioneers who broke their way into the woods of the Southwest and formed settlements there, the rear of the American colonies during the Revolution would have been exposed to Indian attacks in the interest of Great Britain, while such attacks were relied upon as a part of the scheme of subjugation. The present volume relates to the emigration of James Robertson as leader of a party of three hundred and eighty men, women, and children from the Watauga foundation to the Cumberland River, the settlement of Nashville, "the first civilized settlement in the valley of the Mississippi," and the subsequent fortunes of that post and the neighboring stations, down to the conclusion of peace, through Robertson's efforts, between the Creeks and Chickasaws, in 1795. Robertson lived till 1814, and had the privilege of giving eminent services to the Government, by holding the Choctaws and Chickasaws to their allegiance against Tecumseh's efforts to engage them in his conspiracy; and of him the author claims that, judging by the standard of fidelity to duty and devotion to the good of men, there have been few greater characters in American history.

HAND-BOOK OF HISTORICAL AND GEOGRAPHICAL PHTHISIOGRAPHY, with Special Reference to the Distribution of Consumption in the United States. Compiled and arranged by GEORGE A. EVANS, M. D., New York: D. Appleton & Co. Pp. 295. Price, $2.

IN this volume the author has attempted to present a sketch of the development of our knowledge of pulmonary consumption from the time of Hippocrates to the present day, together with the ascertained facts respecting the geographical distribution of the affection. The historical portion, which is mostly a translation from Waldenburg's work, gives the results of the several studies that have been made of the subject, from the days of the "father of medicine" down, with summaries of observations and theories in the order and under the names of their authors; closing with the present aspect of the question as represented by Koch, and the views of other contemporary authors. In the chapters on geographical distribution, the data for countries other than the United States are compiled from Hirsch; and those for the United States from the reports of the census. In discussing the question of "locality in relation to deaths" in the United States, the country is divided into twenty-one "regions," each of which has its peculiar features of climate, soil, topography, prevailing diseases, and death-rate. The general statistics of the United States and the principal cities, in respect to mortality by consumption and other diseases, and the topography and climate, and death-rate, by counties, from consumption, are given separately. The etiology of consumption is next taken up; and the conclusion is expressed, in the last chapter that the antiseptic treatment—natural, by living at high altitude, which is only negatively antiseptic; or artificial, by breathing medicated air—is the best.

BOTANY FOR ACADEMIES AND COLLEGES. By ANNIE CHAMBERS KETCHUM, A. M. Philadelphia: J. B. Lippincott Company. Pp. 324, with 250 Illustrations.

THIS is not a very large book, but it epitomizes the whole science of botany, with a copious inventory of botanical material. While the statements are extremely concise, they are intelligible, and well exhibit the connections and relations of facts. Following the inductive method of Jussieu, the author unfolds the development and describes the structure of plants, from the cryptogamia—"the green stain on our door-stone"—to the highest orders, the magnolia and the clematis, taking each stage in the order of its evolution. "Thus, at the outset, we see the principles upon which differentiation is based." The proof of the theory and the authority for the order followed are indicated in a special lesson on fossils, and this is accompanied by a geological table showing the successive periods of organic and inorganic development in which the predominances of the orders of animals and plants are exhibited side by side. Then, with the plant world thus outlined, the physiology of the subject is taken up, and the separate parts are studied—root, stem, leaf, flower, fruit, tissues, and the forces that govern them. A single deviation from the method of Jussieu—the one usually

followed by systematic botanists—is made in the case of the gymnosperms, which are separated from the dicotyledons and made a distinct class, coming immediately after the cryptogams. "In nature," the author says, "we find gymnosperms associated with the higher cryptogams in the order of development; they form *comprehensive types*, including the characters of cryptogams, monocotyledons, and dicotyledons—they are not true dicotyledons"; and she believes that if Jussieu had known what has been discovered since his time, he would have favored the change. The "Manual of Plants," forming the second part of the volume (some 200 pages), contains lists of all the known orders with their representative genera—a very desirable feature, for few of our manuals give them so exhaustively—with tables of abbreviations and etymons, or roots of botanical terms and names of plants.

SOAPS AND CANDLES. Edited by JAMES CAMERON. Philadelphia: P. Blakiston, Son & Co. Pp. 306. Price, $2.25.

LIKE the other technical hand-books in the same series, this volume consists of the articles in Cooley's "Cyclopædia" on the subjects to which it is devoted, with added information from various sources. The user of the book is assumed to have some knowledge of general and analytical chemistry, hence details of many chemical processes are omitted. In the chapters devoted to soaps, the materials employed are enumerated, and the preliminary treatment of raw fatty substances is described. Lye-testing by the hydrometer and the chemistry of saponification are touched upon, and the apparatus and arrangement of the factory are then set forth. Processes are given for manufacturing a large number of household, toilet, medicinal, red-oil, soft, and industrial soaps, also a dozen methods of recovering glycerin from spent lyes. A chapter on testing soaps closes this part of the volume. In the same manner the manufacture of candles is described. The volume is illustrated with fifty-four cuts of apparatus.

NOT only new but novel is *Quick Cooking* (Putnam, $1), which its author calls "a book of culinary heresies." Its chief departure from the established culinary creed is in asserting that "there is no waste in the kitchen so much to be deplored as wasted time." Many of the recipes in the common run of cook-books are extremely complicated, and few women have the faintest realization of the extravagant amount of time they consume in proportion to the results achieved. They have been made in the most random fashion by adding one substance and manipulation after another, according to the fancy of the maker, and then slavishly followed, without any intelligent effort to find a simpler process for attaining an equivalent result. "Quick Cooking" claims to furnish, in five, ten, or twenty minutes, dishes as delicate and appetizing as those elaborate affairs which one must potter over from twice to ten times as long. This book contains six hundred and thirty recipes, three hundred and forty of which "can, severally or in groups, be made ready for the table in from five to fifteen minutes, and two hundred and fifty of which require from fifteen to forty minutes, or, rarely, an hour's time." A "Black List" of thirty-nine favorite recipes is appended, so called because the most strenuous efforts have not succeeded in materially reducing the time which these dishes require. Each of the three divisions is arranged alphabetically. The whole range of dishes, from soups to sweetmeats, is represented. Prefixed to the recipes are some practical suggestions of a general character, and a table of weights and measures.

"Comfort on $150 a year" is an idea that will provoke from many an incredulous smile, but that this idea can be realized by intelligent management is demonstrated in *How she did it*, by *Mary Cruger* (Appleton, 50 cents). In pleasant story form is told how Faith Arden, with a few hundred dollars and borrowing $700 more on mortgage, buys an acre of rocky hill-side, erects a cottage upon it, which she supplies with furniture from her former home, and some articles constructed by herself, with the aid of a handy carpenter, and then begins housekeeping alone. She has an income of $300 a year, and at the end of six months finds that her living expenses, when there are no extra outlays, need not exceed $150 a year, leaving an equal sum for interest, taxes, and the reduction of her mortgage. This gives her a varied fare and many comforts. A former school-friend, with two children old enough

to be helpful, then joins her, contributing at the rate of $350 a year to the expenses of the household, and the next quarter's account shows a balance of $63, which is increased to $139 for six months. The story is not a visionary one. The author states that it is "an actual portrayal, step by step, of her own experience, her own wonderful success in carrying out a long-cherished theory of comfortable economy. The every-day life described is not a poetically imagined affair, but one that she has absolutely lived and gloried in."

A second edition of the *Chemical Lecture Notes* of Prof. *C. O. Curtman* has been issued, and now includes notes on the metals. The volume is edited and published by Prof. H. M. Whelpley (St. Louis, $1.50), who has extended some of the lecturer's memoranda, and supplied a hundred cuts. Most of the cuts are in the division of chemical physics, which occupies about one third of the book. The chemistry proper is a course in general chemistry, and, although arranged for students in pharmacy and medicine, is quite full, more so than is generally given to these classes of students. Prof. Curtman's notes on organic chemistry are not included in this volume.

Mr. *W. H. P. Phyfe*, author of "How should I pronounce?" has now issued *The School Pronouncer*, based on Webster's unabridged dictionary (Putnam, $1.25). Mastering the 366 pages of this little text-book implies an amount of phonetic drill which should give the pupil a better command of English pronunciation than the average person generally has. The book is divided into three parts, in the first of which the sounds of the English language and the diacritical marks used to represent them are set forth, and extended exercises are given on the two hundred and thirty symbols, consisting of one or more letters, by which these sounds are represented in English spelling; also on the various ways, ranging from two to eighteen, of representing each one of the simple sounds. The lessons in this part are in catechetic form. The author enumerates forty-two sounds in the language, but the distinctions which he makes between *e* in *ermine* and *u* in *urge*, and between *o* in *odd* and *o* in *dog*, will be regarded by many as useless refinements. The second part comprises drills on the elementary sounds, and seventy-seven graded lists of twenty words each for phonetic analysis. Part third consists of twenty-four hundred words often mispronounced, arranged alphabetically, each word, both here and in part second, being respelled phonetically. Many names of persons and places are included in this list. Two appendixes treat of diacritics met with in other books, and eight sounds found in French and German words, but not in English. The volume is printed with large and clear type throughout, and there is no crowding of matter on its pages.

H. C. G. Brandt's First Book in German (Alleyn & Bacon, Boston, $1) is a selection from the same author's "Grammar," containing Part I, or the accidence and syntax, with new indexes, and Lodeman's exercises and the complete English vocabulary. These portions of the larger work have been put together for use in secondary schools, in place of some of the short grammars. The distinguishing feature of the part of the grammar here presented is the complete separation of inflection and syntax. The exercises for translating into German, by Prof. A. Lodeman, are intended for the double purpose of furnishing material for translation and of assisting in the analysis and translation of the more difficult illustrations in the "Grammar." They are framed upon the theory that examples from the German classics are the proper kind of illustrations for a text-book of this order.

PUBLICATIONS RECEIVED.

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POPULAR MISCELLANY.

Fast Ocean Passages.—It was about fifty years ago, with the introduction of iron ships and the screw-propeller, that the era of rapid steamboat traveling began. The paddle-wheel steamer Great Western sailed from Bristol, England, April 8, 1838, and reached New York April 23d. This was welcomed as a great achievement, for the passage across the Atlantic had been made in half the time formerly required. Two years later the Cunard steamers began to sail, the pioneer vessel being the Unicorn, a little craft, which made the passage from Liverpool to Boston, *via* Halifax, in sixteen days. Improvements in the new method of navigation were made in rapid succession. In 1845 the Great Britain —the original ocean screw-steamer—left Liverpool July 26th and arrived at New York August 10th. In May, 1851, the Pacific crossed the Atlantic in nine days, nineteen hours, and twenty-five minutes. The usual time for the passage was still ten or eleven days in 1859. It is only within the last ten years that the speed of ocean-steamers has become phenomenal and their size enormous. The strictly modern class of steamships may be said to have begun with the Arizona, built in 1879, which made the Atlantic passage in the fastest time then on record, attaining a speed of twenty and one third statute miles an hour. In the same year was launched the Alaska, which in 1882 was the first vessel to cross the ocean in seven days, gaining thereby the title of "greyhound of the Atlantic"; but still fleeter "ocean greyhounds" soon appeared. The Oregon outstripped the Alaska, running at the rate of twenty-two miles an hour, and in 1884 was herself eclipsed by the Umbria, making twenty-three and a half miles an hour. Then came the City of Rome, which made the eastward passage in six days, twenty-two hours, and twenty-five minutes; and in February, 1887, the Etruria came to the front with a record of six days and nineteen hours from Liverpool to New York. The Umbria and the Etruria have made several reductions on this time, and the present best record is held by the Etruria, which made the passage from Queenstown to New York in September, 1888, in six days, one hour, and fifty minutes; but we may expect a still further re-

duction by either of these ships on her next trip. Nearly equal speed has been made between England and Australia. At the beginning of the century this passage required eight months by sailing-vessels, and is now made by steamers in about six weeks. The Ormuz, launched in 1887, was designed to greatly reduce this time, and, although at first not realizing expectations, in October of the same year she exceeded them by covering the distance between London and Adelaide in a trifle under twenty-four days.

Colors of Flying-Squirrels.—A paper was read in the American Association, by Mr. W. E. Taylor, on color variations of Nebraska flying-squirrels. The American flying-squirrel presents a range of geographical variation in size quite unparalleled in other members of the *Sciuridæ*. On the other hand, the coloration is remarkably constant. The local variations in color were illustrated by descriptions and comparisons of five specimens examined by the writer, all collected near the Missouri River, in Nebraska, at different times and places. The writer concludes: 1. That the measurements correspond to the Northern variety, while the colors correspond more nearly with the Southern varieties. 2. Local variations in color are great, these variations existing in members of the same nest. 3. Locally, at least, the two varieties appear to grade into each other. 4. The degree of coloration on some parts of different specimens does not vary in the same rate.

Value of Experimental Psychology.—Pointing out the advantages of the experimental method of psychological investigation, combined with the introspective, Dr. J. McK. Cattell, of the University of Pennsylvania, says: "Experiment is not meant to take the place of introspection, but is meant to make scientific introspection possible. The study of consciousness is, as we all know, fraught with peculiar difficulties. It is not easy to be at once the observer and the observed. The eye sees not itself, and the phenomena are both complex and transient. The best results have been obtained when introspection has been combined with the study of the objective manifestations of the contents of other minds, more especially when these have on the one hand become fossilized, as in language, customs, art, etc., or, on the other hand, are relatively simple, as in children, in savages, and in disease; but, under circumstances the most favorable to scientific observation, there are serious difficulties in the way of exact observation and measurement, and it will be found in psychology, as elsewhere in science, that experiment gives the most trustworthy and accurate results. Experiment calls up the phenomena to be studied when wanted, and by keeping certain conditions constant and by altering others gives the best chance for analysis; above all, it enables us to photograph the transient phenomena and subject them to objective examination and measurement."

Continental Centers. — The orographic centers of the several continents have been graphically determined by M. A. de Tillo as follows:

CONTINENTS.	Latitude.	Longitude (from Greenwich).
Asia, with Europe	48° N.	85° E.
Africa	4° N.	127° E.
North America	45° N.	102° W.
South America	14° S.	56° W.

These four centers form a fairly regular quadrilateral. The longest side (92°) is the one between the Asiatic and North American centers. The African center is distant 82° from the South American center. It is worthy of remark that the distance between the centers of the double continents is approximately the same, the center of Asia being 70° from that of Africa, while the centers of the double American continent are separated by 73°. The geometric center of the four continents is in the region of the Azores and the Canaries.

The Energy in an Earthquake.—After explaining, in the American Association, the impossibility of calculating the intensity of an earthquake more than approximately, Prof. T. C. Mendenhall applied a formula to determine the energy involved in the Japanese earthquake of January 15, 1887, which disturbed over 30,000 square miles of territory. He said: "Assuming a mass of 150 pounds per cubic feet, and taking a cubic mile as the volume to be considered, I find that to put it in vibration required the

expenditure of 2,500,000,000 pounds of energy. Assuming that an area of 100 miles square with a mean depth of one mile was thus in vibration at any one instant of time —which is not improbable, considering the known rate of transmission and the long duration of the earthquake—the amount of energy thus represented would be 25×10^{12} foot-pounds. This energy might be generated by the fall under the action of gravity of a cube of rock 1,000 feet on each edge, the mass of which would be 75,000,000 tons, through a vertical distance of 166 feet." Also, assuming certain magnitudes, "I find the energy of a cubic mile of the Charleston earthquake, taken near enough to the epicentrum to be disturbed as above assumed, to be equal to 24,000,000,000 foot-pounds. The speed of transmission of this disturbance has been pretty well determined by Newcomb and Sutton to be approximately three miles per second, so that a cubic mile would be distributed in one third of a second. To do this would require 130,000,000 horse-power. Assuming that an area about the epicentrum 100 miles square was thus disturbed, the energy would be that of 24×10^{13} foot-pounds, and the rate of its expenditure would be that of 1,300,000,000,000 horse-power."

Gems.—The diamond became generally employed as a finished gem in France during the first quarter of the fifteenth century. The art of cutting it has gradually improved and developed, until now, two million five hundred thousand carats of diamonds are annually cut in Amsterdam. The principal source of supply has shifted from India to Brazil, and now to South Africa, whose Cape diamonds at present furnish ninety-five per cent of European supply. The quality of these diamonds, according to Mr. Alfred Phillips, has been purposely underestimated by interested parties. It is true that colorless diamonds have been found in the smallest proportions in South Africa, but it is equally beyond dispute that large numbers of the whitest and most faultless diamonds are exported from the Cape, while the mass of the material is conspicuous, whether white or colored, for its brilliancy. The ruby is next highest in value, and after it comes the sapphire, which is only another colored ruby. Although the cheapest of the major gems, its loss, according to Mr. Phillips, would be, on account of its intrinsic value and unrivaled blue color, a greater misfortune to the art-goldsmith than that of either the ruby or the emerald. The emerald is one of the most beautiful, although the softest, of the precious gems, and is easily fusible with borax into a colorless glass. The true emerald occurs in crystals seldom over one inch in length. The so-called Oriental emerald of India is not an emerald, but a green ruby or sapphire. The exquisite tones peculiar to the minor gems, or those of lesser value, establish them as a separate category when compared with the magnificent or acknowledged gems. Among them the amethyst was worn in the middle ages as an amulet and preservative in battle, and was distinguished as a pious or episcopal gem, figuring wherever it was desirable to impart serious beauty or dignity to the property of the church. Then we have the chrysolites, the topazes of various hues, and the garnets, Oriental varieties of which ranked with gems of a higher order rather more than a century ago. The opal was held in the highest repute in ancient times, first for its beauty, and then because its own mythology constituted it a harbinger of love and good-will. It has lost in value in modern times, through the influence of a silly superstition. The selenite, or moonstone, is a gem of great beauty, and admits of a great variety of applications, on account of the softness of its tint, which enables colored gems, diamonds, and enamels to be agreeably associated with it.

About a Crocodile.—"Ubique" (Parker Gillmore) tells, in "Land and Water," of a crocodile which he saw in Java almost seventeen feet long. "It frequented the vicinity of a place where the village women were in the habit of assembling to wash their clothes, and, if report spoke truly, many were the Malay females it had carried off. At length it was captured by using a live dog for bait. After being transferred from its watery home to the commandant's garden, it was safely secured upon the lawn by innumerable moorings. Our assistant surgeon administered the saurian an immense dose of strychnine, enough, as he said, to poison a regiment, but it had not the slightest injuri-

ous effect upon the brute. Its skin, I believe, is still to be seen at the Dutch East Indian Museum at Amsterdam. If there is one animal more than another detested by the human race, it is the crocodile, and, if possible, the hunter or sportsman hates it more than all others combined, for it is certain to carry off his dogs sooner or later." The call of the crocodile is described as being like the snappish bark of an aggrieved dog.

Two Snake-Stories analyzed. — Two American snake-stories—one about a singing snake said to be in the Smithsonian Institution, and the other about a rattlesnake that was said to have poisoned itself—having been referred to Dr. Arthur Stradling for a verdict on their credibility, he has pronounced them both intrinsically false. No snake on earth, he says, has any vocal apparatus, properly so called, whatever, or is capable of producing any respiratory sound beyond a hiss or a wheeze. But they may in the last stage of canker give vent to a noise almost amounting to a squeal, caused by forcible expiration; and, if they happen to have swallowed a frog alive, he may croak audibly in the snake's stomach. To what extent a poisonous serpent's bite is noxious to itself is doubtful. "Probably it inflicts mechanical injury only upon its own body, or upon those of its immediate congeners. . . . I have seen cobras bite and shake each other like dogs over disputed rats, and I recollect a jaboia being heavily mauled by a puff-adder under like circumstances, with a little swelling and inflammation only arising in either case." Dr. Stradling has a rattlesnake that bit itself severely, with no more result than a little tumefaction of the wound; and it is still living and well.

Fading Photographs.— Common photographs, in which the dark parts consist of finely divided silver on a film of albumen, rarely remain unchanged in appearance for twenty years. The white parts sooner or later take on a sickly yellow tinge, and, when this change has begun, the picture is doomed, unless immediate steps are taken to preserve it. Treatment by skillful hands with a weak solution of mercuric chloride (corrosive sublimate) may arrest decay, but will not restore the clearness and freshness of the print. A better plan is to have the picture copied by some platinum-printing or carbon-printing photographer who does a large enough business to employ a skillful retoucher. The process of getting a good permanent photograph from a bad fading one is complicated, and requires skill. Photographs in which the dark parts are formed of platinum-black are the most durable sort known. The best photographers will furnish permanent pictures if their sitters demand them, but such pictures are in plain black and white—without the chocolate tinge of the common stylo—unless the carbon process with a pigment of the requisite color is employed. The greatest enemies to the permanence of common silver-prints are traces of chemicals not fully washed out of the print, dampness, and the action of sulphur or its compounds. The last of these agencies is the most difficult to guard against. The albumen with which the photograph-paper is coated contains sulphur, and a familiar instance of its action is the blackening of silver egg-spoons. The air also, especially in cities, contains sulphurous gases derived from sewers, and from the burning of coal and gas.

Warmth for the Injured.—A correspondent of "The Lancet" urges the addition of some source of artificial heat to the equipment of ambulances in cold weather. "We all know," he says, "how depressed the system is after accidents; how difficult it is to restore warmth; and if to this we add exposure to a low temperature on the ground in frosty or wet weather, any amount of blankets can not add warmth, only retain what little there remains in the body. One need only picture one's meeting with an accident three or four miles from home, late in the evening, without additional clothing, lying for one or two hours on the damp ground, to realize how some means of conveying heat to the feet and hands would be welcomed." The writer then describes the means which he has used, consisting of a tin-lined copper bottle, holding a gallon and a half, and closed with a screw-plug. It is of concavo-convex shape, for feet, chest, etc. If filled with boiling water and rolled up in a blanket, it will remain quite hot for three

hours, and be fairly warm after seven hours. Some of the hot water can be given to the injured person to drink, with the addition of beef-extract, spirits, cocoa, etc. He mentions also a particular pattern of kerosene stable-lamp, which, if placed inside a covered ambulance-wagon, would materially raise the temperature of the interior.

Boys' Color-Knowledge.—Some test examinations recently made in one of the English board-schools indicate that too much may have been made out of color-blindness, and that want of instruction rather than want of discrimination may be at fault in many of the cases where disability is supposed to exist. Some of the pupils at the examination in question were awkward at first, and made great mistakes, but needed only a little setting right to prove that they could distinguish the colors correctly. One boy was in the habit of calling black white and white black; as for the other colors, he had never been particular to name them, or think about them exactly, supposing it to be a matter of little importance. Of a hundred boys examined upon the seven principal colors, not one showed any real suspicion of color-blindness. Of two hundred boys examined in graduating and matching shades, none found any difficulty after practicing for about an hour; and every one was soon able to distinguish all the ordinary colors without the least difficulty.

Vitality of Microbes in Water.—According to Prof. Frankland's relation of experiments on the vitality of various microbes in water, great differences in behavior are observable. Of Koch's comma spirillum of Asiatic cholera, Finkler-Prior's comma spirillum of European cholera, and the *Bacillus pyocyaneus*, which produces the greenish-blue coloring in abscesses, the latter exhibits much greater vitality than either of the other two. It lives and increases many times for more than fifty days. Koch's comma spirillum disappeared from pure water in nine days, but flourished and increased in London sewage; while Finkler's spirillum disappeared in less than one day. In some cases when organisms not the natural inhabitants of water are introduced into it, a large proportion of them are at first destroyed, but a multiplication in numbers takes place afterward. The *Bacillus anthracis* in its bacillus form is destroyed with comparative ease, but the spores have remarkable vitality. Mr. Arthur Downes has remarked how, in tubes containing more than one form of microbe, the first dominant form will gradually grow more and more feeble until it seems to become extinct and is succeeded by races of a different kind.

The Arts of Life in Anthropology.—The one great feature which it is desirable to emphasize in anthropological museums, said Lieutenant-General Pitt-Rivers, in the British Association, is evolution. To impress upon the mind the continuity and historical sequence of the arts of life is one of the most important lessons to be inculcated. It is only of late years that the development of social institutions has at all entered into the design of educational histories. The arts of life have never formed part of any educational series. Yet, as a study of evolution, they are the most important of all, because in them the connecting links between the various phases of development can be better displayed. Laws, customs, and institutions may, perhaps, be regarded as of greater importance than the arts of life, but for anthropological purposes they are of less value, because in them, previous to the introduction of writing, the different phases of development, as soon as they are superseded by new ideas, are entirely lost, and can not be reproduced except in imagination; whereas in the arts of life, in which ideas are embodied in material forms, the connecting links are in many cases preserved, and can be replaced in their proper sequence by means of antiquities. For this reason the study of the arts of life ought always to precede the study of social evolution, in order that the student may learn to make allowance for missing links, and to avoid sophisms and the supposition of laws and tendencies which have no existence in reality. To ascertain the true causes for all the phenomena of human life is the main object of anthropological research, and it is obvious that this is better done in those branches in which the continuity is best preserved. In the study of natural history existing animals are regarded as present phases in the devel-

opment of species, and their value to the biological student depends, not so much on their being of the highest organism, as on the paleontological sequence by which their history is capable of being established. In the same way existing laws, institutions, and arts, wherever they are found in their respective stages of perfection, are to be regarded simply as existing strata in the development of human life, and their value from an anthropological point of view depends on the facilities they afford for studying their history. The arts of life are of paramount importance, because they admit of being arranged in cases by means of antiquities in the order in which they were actually developed.

The Human Struggle for Existence.—The Malthusian theory was the subject of a discussion at the British Association. A paper by Mr. Edwin Chadwick went to show that, where wages increase, the pressure of population on means of subsistence is diminished; that, instead of the cost of production of land being fixed, it is generally reducible by science and machinery, while the amount of production may be everywhere augmented; and that, instead of pestilence being a natural check on population, it does not diminish its pressure, but serves to weaken the population and diminish its productive power and increase its pressure on the means of subsistence. The author could not descry the limits of a further advance of prosperity in the country with a further increase of population. Mr. Park Harrison thought that war was not an unmixed evil as a factor of population, and that it was interesting to note the care we took at present at vast expense to enable miserable specimens of humanity to survive and increase that part of the population which is really the main element of the unemployed. The members of society thus produced were perfectly incapable subjects, carefully nursed, and brought up as if they were going t oinherit large estates. Natural selection should be allowed to have fair play. It was interfering with the laws of nature to do so much in the direction of perpetuating the survival of the unfittest. Mr. W. L. Bros said that in old times war, by the operation of the rules that prevailed, eliminated the weakest members of society; but, by the system of fighting in the nineteenth century, the soldier should be a picked man of the community. The population, therefore, which suffered from war lost its best, not its worst members. War also added largely to the disproportion in the numbers of the sexes, and meant the prevalence of many social irregularities which tended to degrade the community as a whole, and to cause the survival of a lower type. Sociologists believe that the commercial competition of the present day is acting very much as war used to act in earlier days. The strong, the competent, and the mentally and physically efficient are succeeding in the struggle for life; the feeble in mind and body and in resources are being eliminated by industrial competition. It is desirable, in the interests of the health of the community, that this competition continue. Another speaker maintained that the children of the working classes did not, as a rule, contribute to the lazy population of the country. A poor man with six daughters practically owned a fortune, because they could become useful servants; and if he had three or four sons, the young men could obtain work if capable for it. It was the middle and higher classes who contributed to the surplus and lazy population. This could be seen by the large number of genteel young men who every day crowded after a vacant clerkship. Parents should not be afraid to bring up their sons to learn a useful handicraft.

NOTES.

The statistics of the Japanese Empire for 1887 show that commercial enterprise is developing there in a remarkable degree. The foreign trade of the country has increased more than 86 per cent in ten years. In connection with the addition of 151 miles of railway to the 370 miles before built, the pertinacity with which the Japanese insist upon furnishing their own capital, and not borrowing from abroad, is remarked upon. Naval stations are building at Kune, Nagasaki, and Tauchina Island. A system of water-works has been completed at Yokohama, while such concerns were wholly unknown under the old system; 111 commercial and industrial companies were formed last year in Tokio, Osaka, and Kioto, having an aggregate capital of $21,500,000; and in all, shares to the extent of more than $71,000,000 taken up by the people.

DR. JOSEPH WIGGLESWORTH, of Rainhill Asylum, regards morality as of developmental origin and growth. Morally insane persons exhibit a change in their affective nature, having their altruistic feelings greatly impaired or lost. Moral insanity might exist by itself, but it is more usually a stage in the development of intellectual insanity, showing itself generally precedent to intellectual change; the moral faculties are often the first to be affected when the cerebrum is the subject of slowly progressing disease. There are also moral idiots or imbeciles—children who, with little or no impairment of intellect, show great deficiency or almost total absence of the moral faculties, and are incapable of acquiring them.

THE kava-root (*Piper methysticum*) of the Society and South Sea Islands is the basis of the intoxicating drink of those regions. Women and girls are employed to chew the root, and, when well masticated and mixed with saliva, it is ejected into bowls, mixed with coca-juice, and left to ferment. Both natives and whites of the lower classes are very fond of it. The natives use it as some among us do wine, under the idea that it will help them along in important undertakings.

THE Franklin Institute calls attention to the fact that it is empowered to award a gold medal, founded by the legacy of Elliott Cresson, of Philadelphia, which is granted either for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufacture, or for ingenuity, skill, or perfection in workmanship. It is also empowered to recommend the award of a premium and medal, founded in 1816, by John Scott, of Edinburgh, by a legacy to the city of Philadelphia, for rewarding ingenious men and women who make useful inventions. The premium is not to exceed twenty dollars, and the medal is to be of copper, and inscribed "To the most deserving." Full information respecting the manner of presenting reports upon discoveries and inventions may be obtained by addressing the Secretary of the Franklin Institute, Philadelphia, Pa.

A TECHNICAL university is contemplated in the colony of Victoria. A minute has been issued by the Minister of Public Instruction of the colony, on the policy of founding such an institution, in which the evidence taken before the Royal Commission on Technical Instruction is largely drawn upon. The estimates of cost embrace between £500,000 and £1,000,000 for founding the institution, and a yearly endowment of £30,000.

THE district of Oulliassutai in Mongolia has been suffering for two years from an invasion of rats, which have destroyed all the grass of the pastures. The post-carriers have been obliged to change their routes, not only because of the difficulty of supporting relays of horses in the infested districts, but also because the roads have been made dangerous by innumerable burrows.

OBITUARIES.

IT was recently announced that General Nicholas Prjevalsky, the distinguished Russian explorer, had died in Central Asia, on his way to Thibet, of typhus fever. He had started from St. Petersburg on the 31st of August, in an attempt to reach Lhassa, in Thibet. When last heard from previous to his death he had reached Vernoje, where he intended to equip his party. A portrait and sketch of him will be found in the number of this magazine for January, 1887.

PROF. THEODOR KJERULF, who has recently died at Christiania, Norway, besides being distinguished as a contributor to scientific literature, was versed in poetry and music, and a lover of the fine arts. He was born in Christiania in 1825; traveled in early life in Norway collecting folk-lore, and in Iceland, Tyrol, and other parts of Europe for geological study. He became attached to the geological department of the University of Christiania in 1850, and a professor there, and Director of the Geological Survey in 1866. He published works on the silurian basin of Christiania and the geology of southern Norway, and was the author of more popular books on scientific subjects.

JAMES STEVENSON, of the United States Geological Survey, died July 25th. He was born in Maysville, Ky., was business manager in the field of the Hayden Survey, was especially interested in American ethnology, and was a well-informed zoölogist.

MR. WILLIAM GIFFORD PALGRAVE, an eminent traveler, died at Montevideo, where he was British minister, in his sixty-third year. He was author of a "Narrative of a Year's Journey through Central and Eastern Arabia," which was a great fund of information respecting that little-known country.

SILAS STEARNS, an ichthyologist of thorough and exact knowledge, died at Asheville, N. C., August 2d. He was made a special agent in 1880 of the United States Fish Commission and Census Bureau, in charge of investigations of the marine industries of the Gulf of Mexico, with the fishes of which and their economical value he was particularly well acquainted. According to President Jordan, his early ambition to become a naturalist "met with discouragement in the absurd statement, made by some one in Washington, that no successful work in science would be possible without a classical education," but evidently was not put down by it.

DR. PETER GRIES, an English chemist, died September 6th, of apoplexy. He was best known from his discovery of the diazo compounds.

JOHN BERNARD STALLO.